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MECHANICAL ENGINEERING

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National Research Council to Coördinate Research Throughout the Country

FEBRUARY 1922

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Contributors and Contributions

Education and Training in the Industries

The work instituted by the A.S.M.E. Committee on Education and Training in the Industries is exceedingly important and a valuable contribution to it was presented in the paper by Dean Robert L. Sackett at the last A.S.M.E. Annual Meeting and given in abridged form in this issue of MECHANICAL ENGINEERING. Dean Sackett is dean of engineering and in charge of the Experiment Station at Pennsylvania State College, a position he has held since 1915. Previous to that he taught at Purdue University for eight years and during that time he was engaged in extensive consulting work in the hydraulic field. He is a graduate of the University of Michigan, in the class of 1891.

The second Annual Meeting paper on this subject of Industrial Training was given by D. C. Buell, of Omaha, Nebraska. Mr. Buell is director of the Railway Educational Bureau which coöperates with a large number of railroads in their educational work, and he has had a long experience in supervising railway training. His paper appears in slightly abridged form.

Operation of Locomotives and Cars

The paper by William Elmer, presented at the A.S.M.E. Annual Meeting Railway Session and abstracted in this issue of MECHANICAL ENGINEERING, gives the fundamentals upon which the maximum operation of locomotives and cars depends. Mr. Elmer has been in the service of the Pennsylvania Railroad since his graduation from Princeton University in 1894. He has acted as master mechanic, and superintendent of motive power on various divisions of the Pennsylvania Lines, and at present is superintendent of the Middle Division. He was also responsible for the design and construction of various shops at Altoona, Juniata, etc.

Mr. Elmer's paper is followed by an abstract of the discussion at the Railway Session.

Tests of Oil Burning in Marine Boilers

The Annual Meeting paper by F. W. Dean, abstracted in this issue of MECHANICAL ENGINEERING, supplements a paper on testing U. S. Shipping Board boilers, given before the 1919 A.S.M.E. Annual Meeting. Mr. Dean, who served in the steam-engineering department of the U. S. Shipping Board during the War, has had long experience in the consulting field of power and mill engineering. He has been a member of the A.S.M.E. since 1883 and served as its vice president from 1895 to 1897. He graduated from Lawrence Scientific School, Harvard University, in 1875, and served as instructor there for eight years.

Aeronautic Problems

The A.S.M.E. Aeronautic Division at its first Annual Meeting Session devoted its program to the problems of the commercial operation of air lines and also to a technical consideration of some aeronautic materials. Two papers on air line operation were given. The one by Major L. B. Lent was abstracted in the January issue of MECHANICAL ENGINEERING. The other, by R. B. C. Noorduyn, appears in this issue. Mr. Noorduyn's contribution is extremely valuable as it gives a clear idea of the preliminary difficulties that must be met and overcome before a successful air transportation is thinkable in this country. Mr. Noorduyn is a representative of the Netherlands Aircraft Manufacturing Company.

The papers on materials were presented by R. R. Moore, D. T. Brown and R. J. Diefenbach. Mr. Moore, who is chief of the Physical Testing Branch at McCook Field, presented the results of a study of the elastic properties of small wire cable, a most important contribution of knowledge necessary for efficient design of aircraft. The paper by Messrs. Brown and Diefenbach gives the results of an investigation of the strength of plywood webs of a form resembling airplane ribs. Mr. Brown is sales engineer for the American Radiator Company, Philadelphia, Pa., and Mr. Diefenbach is with the Worthington Pump and Machinery Corporation.

Fuel and Its Combustion

The A.S.M.E. Annual Meeting Fuel Session was well attended and the papers were fully discussed. All of the papers have previously appeared in MECHANICAL ENGINEERING and the discussion is abstracted in this issue. Following the Fuel Session, R. Sanford Riley, president of the Sanford Riley Stoker Co., displayed motion pictures of a furnace in operation. The interest in the picture here described made it necessary for Mr. Riley to repeat it.

Mechanical Engineering Research

The A.S.M.E. Research Committee held a notable conference at the last Annual Meeting, at which the duties of the National Research Council Mechanical Engineering Advisory Committee were discussed as were other important matters pertaining to the research activities of the Society. Two valuable papers on research were presented by F. A. Wardenburg, assistant chief engineer of E. J. du Pont de Nemours & Co., and Arthur W. Thomas, assistant professor of food chemistry at Columbia University. The report of the A.S.M.E. Committee on Lubrication was presented and progress of the research with the Upper Limits of the Steam Tables was discussed.

Editorials

The editorial pages of this issue contain an interesting account of the power possibilities of the Colorado River, by O. C. Merrill, executive secretary of the Federal Power Commission. There is also an appeal for a comprehensive program of industrial standardization from E. C. Peck, chairman of the A.S.M.E. Standing Committee on Standardization.

A.S.M.E. News Well Received

The first issue of A.S.M.E. NEWS, the new semi-monthly publication of the A.S.M.E., was mailed under date of December 22, 1921. It has attracted wide attention and many favorable comments have been received. It is evidently satisfying a need for a frequently issued organ devoted to A.S.M.E. activities.

A.S.M.E. Spring Meeting, Atlanta, May 8–11, 1922. Papers for this meeting must be in Secretary's hands by March 15.

MECHANICAL ENGINEERING

Volume 44 February, 1922 Number 2

A Review of Industrial Education and Training

Symposium at Annual Convention of A.S.M.E. Develops Many Principles of Value in Formulating Standard Code of Procedure in Industrial Education

FOR several years The American Society of Mechanical Engineers has maintained a relationship with the universities and colleges of this country, and it was but natural that in time the interest of this organization should be extended toward the technical and trade schools which play such an important part in our system of industrial education.

Two years ago the scope of the Committee on Relations with Colleges was extended to include Education and Training for the Industries, and the name of the committee changed to the more comprehensive one of Education and Training.[1] The symposium on this subject at the recent Annual Meeting of The American Society of Mechanical Engineers was the second public meeting held under the auspices of the enlarged committee. While conforming with the central idea of the convention, by showing how "technical education for industrial employees is for the purpose of *preventing waste* of money, materials, mechanical power, and human energy," the papers and discussions brought out many principles which will be utilized by the committee in formulating a standard code of procedure in industrial education. This can be adopted by the Society and recommended to the industries and the educational authorities.

Two papers were presented and discussed at the session held on the evening of Monday, December 5, in the auditorium of the Engineering Societies Building, New York. Dean R. L. Sackett, State College, Pa., presented the first paper, on Education and Training in the Industries, and D. C. Buell, Director of The Railway Educational Bureau, Omaha, Neb., presented the second, on Education and Training on Railroads. President E. S. Carman presided over the session and Chairman W. W. Nichols of the Committee presented the speakers. An abstract of the papers and discussions follows.

Education and Training in the Industries

By R. L. SACKETT,[2] STATE COLLEGE, PA.

THE education of the worker in the United States has been neglected, while in Europe special types of instruction have been in use for some time. The continued growth of apprentice and continuation schools there indicates that they perform a valuable service. However different the conditions abroad and here may be, the fact remains that more systematic methods must be employed to improve skill, to prepare men for promotion, and to inform our wage earners concerning American industrial methods and ideals.

The early apprentice and his master constituted the first industrial school. The apprentice system failed to meet the need of changing industry and became relatively unimportant, when the age of power and labor-saving machinery arrived about 1876.

Continuation Schools

Probably the earliest continuation school was that organized in Munich, Germany, where daytime attendance at commercial and industrial schools was made compulsory for all under eighteen years of age engaged in commerce or industry. Besides the continuation of their general education in history, German, mathematics and citizenship, separate classes are arranged for the youths of each trade and in these classes both practical and theoretical instruction are given in the trade by skilled workmen and special instructors. It is to be noted that Germany, in the beginning, brought the public schools and industries into close coöperation in the conduct of the continuation school.

In Great Britain the Fisher Bill for compulsory continued education was passed in the Education Act of 1918. This bill provides for a national system of public education for those 14 to 18 years of age. The system is being applied gradually and the number of students will increase from 600,000 to about 1,200,000 in 1925. Attendance of two half-days per week is required and the subjects are divided into—

a Study of English, Geography, History, Mathematics, etc.

b Instruction in Handicraft, Practical Science, Vocational Instruction.

c Physical Training, including drill, swimming, gymnastics, organized games.

The possibilities of the continuation school were first recognized in the United States about eight years ago, since which time twenty states have established such schools. The need for them as a part of our state system was emphasized by Charles W. Eliot, President Emeritus of Harvard College, who said in 1916:

> A survey of the programs of existing American secondary schools—public, private and endowed—would show that as a rule they pay little attention to the training of the senses and provide small opportunities for acquiring any skill of eye, ear, or hand, or any acquaintance with the accurate recording and cautious reasoning which modern science prescribes.

In support of the continuation school and of industrial instruction in general, the National Association of Manufacturers in convention May, 1913, declared:

> First, It is the purpose of vocational education to save, educationally, that 50 per cent of the children of the land who now leave school at the end of the sixth grade, undirected, unskilled, uninformed, and to train them and others of all ages in the essentials of successful and happy workers in their chosen occupations, in commerce, in manufacturing, in agriculture, and in home making.[1]
>
> Second, It is essential that the teachers in vocational schools shall have had extended experience in actual employment in the occupations taught, to the end that the instruction be practical and meet actual conditions.
>
> Third, Failure has marked every attempt at vocational education not directed principally by employees and employers from the vocations, thereby assuring that the instruction given shall justify the confidence and hope of students, parents and the vocational interests whose coöperation is essential.

In 1913 the state of Wisconsin began a continuation-school program requiring one half-day per week attendance by those between 14 and 16 years of age. Following this example nearly half the states have since enacted laws of a similar character, but most of them require attendance two half-days per week.

In general, the program of the continuation schools in this country has included instruction in English, mathematics, history and then vocational instruction along the trade which the employee is pursuing. Classes in any community are therefore divided according to the principal occupations in the local industries. Attendance is required during two half-days per week and this time

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[1] W. W. Nichols, *Chairman*, C. R. Richards, R. L. Sackett, J. C. Spence, Ira N. Hollis.

[2] Dean of Engineering School. Mem.Am.Soc.M.E.

Abstracts of papers presented at the Annual Meeting, New York, Dec. 5 to 9, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] *American Industries*, vol. 13, no. 11, pp. 27–38.

is deducted from the maximum number of hours of employment permitted per week. The employer is required to make provision for the absence of those who are required to attend the continuation school.

Pennsylvania was the second state to provide continuation schools, and in 1915 when the act was passed there were probably "at least 50,000 children between the ages of 14 and 16 who had left school to go to work." Why do they leave the common schools? A very recent report of the Pennsylvania Department of Public Instruction says, "Many children when asked why they leave school to go to work give economic necessity as the reason." Careful and conclusive investigation shows that very few children leave school to go to work because of financial necessity. Thirty-five per cent of the children when first asked give economic necessity as a reason, but the invariable result of investigation is to reduce this number to between 10 and 15 per cent. In the majority of cases further questioning brings out the statement that the desire to leave school is the result of "lack of interest, the failure to make the next grade, dislike of a teacher, distaste for one or another of the prescribed studies, the desire for clothes, spending money, or a craving to try something different." Whatever the reason may be, the fact remains that the secondary- and high-school systems which have been built up in the United States, valuable as they are, do not serve all the needs of all the people and the continuation school is an attempt to appeal to and to serve the objective type of mind, the restless, those who are not adapted to our public schools, or are led to think they do not meet the workers' needs.

The instruction given in the typical continuation school requiring attendance eight hours per week is about as follows:

	Hours
I GENERAL CLASSES:	
English, Vocational Guidance and Occupational Analysis	2
Industrial Geography, Citizenship, Hygiene, Music, Recreation, Arithmetic, Drawing	2
Industrial Arts and Home Projects	1½
Reading for Appreciation	½
II PREVOCATIONAL CLASSES FOR "SELF-DISCOVERY:"	
English, Vocational Guidance and Occupational Analysis	2
Industrial Geography, etc	2
Related Arithmetic and Drawing	2
Commercial Household Arts or Industrial Prevocational Work	2
III VOCATIONAL CLASSES:	
English, Social Science, Industrial Geography	2
Related Arithmetic, Drawing and Hygiene	2
Commercial Home Making or Industrial Vocational Work. (In school, shop or in place of employment under special instructor)	4

Students are assigned to one or the other, according to their preparation and their needs.

What are the purposes of the continuation schools? I quote from the Pennsylvania Bulletin showing a realization of a supreme need and of an immense service which these schools may perform if rightly directed.

These children must learn how to adjust themselves to the task of earning a living, realize that for practically all of them promotion will be slow and must be earned, that shifting from job to job is a wasteful practice, that they must learn to be responsible punctual, industrious, willing to render cheerful service, if they are to succeed.

Industry grants them little opportunity for instruction on the present job, the line of promotion, or the next job. Especially does industry fail to give them outlook and opportunity toward the permanent job which in a few years will replace the present and temporary job.

Therefore, the continuation school must provide opportunity in fundamental subjects for review and drill on what is already known, for advanced work on what is yet unknown; and for applying what is studied in school to the experiences of every day. The school must help the child to analyze the present job and the job to come, give vocational counsel and vocational guidance, provide opportunity for prevocational shop experience which eventually will become vocational experience. While making the child more efficient on the present temporary job the school must prepare the child for the probable permanent life job.

Because many of these pupils are irresponsible at fifteen years of age and may be more so at nineteen years, there must be training in the things that make for decent, restrained, respectable citizenship and community relations. And because all, both boys and girls, will soon be voters, there must be training in civics, in knowledge of the structure and functions of democratic government.

Lest the pupils become careless in personal habits and in regard to the safety of themselves and others, there must be training in personal hygiene, community hygiene, and safety-first principles.

Because the gang spirit is strong and is the inevitable characteristic of adolescent youth, it must be made a force for right doing through the influence of assembly gatherings and the development of school spirit. Because normal youth must have recreation and leisure, the school must train and guide in the profitable use of recreation and leisure.

The Need for Coöperation. A school system which can perform all these functions or one-half of them is such a valuable asset to industry and hence to society that its aid should be invoked. As the English Labor Party pointed out, these aims cannot be reached without the closer coöperation of the industries with this type of school. None of the legislation so far passed provides for the active advice of industrial leaders in the community. This is important if the continuation school is to fulfill all its functions as above set forth. On the other hand, it would be a serious error to make this type of school merely a manual-training vestibule to factory employment. It is a social institution as well as an industrial one. It is even more important to industry just now that half the effort of our schools be applied to fundamental training in habit and character formation, to right thinking and right acting about work and citizenship.

APPRENTICE SCHOOLS

The Union Pacific, the New York Central System, the Santa Fe, and the Pennsylvania Railroad organized schools for apprentices of one kind or another beginning in 1874 when the Lake Shore & Michigan Southern Railroad began a school for apprentices at its Elkhart, Indiana, shops, but attendance was not compulsory until 1901. In 1886 evening classes for apprentices were organized at the Jackson, Michigan, shops of the Michigan Central Railroad. Later the class hour was shifted to the close of the work but was not on company time. Still later the instruction was shifted to the morning hours and on company time, which is now the general rule. The Pennsylvania Railroad began its apprentice school in 1911 and has gradually extended the plan until there are now eleven schools east of Pittsburgh. At first the position of labor unions toward industrial education was one of hostility, but this has changed in the main and now the International Typographical Union has its own extensive schools, the first of which was established in 1908.

To the foresight and frugality of Germany is due the completeness of her educational program, which for a half-century has excelled in the applications of chemical and electrochemical research to the promotion of her industries. The beet-sugar industry, the production of synthetic dyes, the by-product coke oven, reforestation, the improvement of river navigation, have been the product of scientific education directed toward the development of new resources and the reduction of costs. More recently she has anticipated the solution of the human problem in industry by a plan of intensive practical education for every youth who leaves school to earn a living. Furthermore, her industries have been copartners with the state in the conduct of the program—an important factor in which she still leads the United States.

The experience and present developments in European industrial education are of interest because they exhibit the trend of educational affairs and the effects of the war. Germany now probably possesses the most complete educational system of any country in Europe. Boys are required to attend the usual courses in elementary school instruction up to the age of 14, but during the last year they are allowed in some cases to work in the trade-school shops during their Saturday half-holiday, provided that their health is good.

The trade apprenticeship course is from three to four years in length, which is somewhat shorter than is usual in Great Britain. The distinctive thing about German trade training is that it is given in company shops rather than in public trade schools. For instance, the Siemens & Halske Company have special school shops where apprentices attend for one year and also return for the last three months of their apprenticeship to make a "test piece." The latter is used as a part of the examination for licensing as a journeyman. At the end of the course the apprentice goes before an examining committee of experts who test his knowledge of the trade and to whom he submits his "test piece." Successful ones secure a journeyman's certificate. The apprentice then goes on and obtains a master's certificate. The apprentice training in the industry must be supervised by one having a

master's certificate. Special short courses of about eight weeks' length are given for those who desire a master's certificate. Those who attend the apprentice school in a recognized plant are exempt from attendance at the government continuation schools.

In France there is no national scheme for training artisans. In Paris and other industrial centers, however, evening and Sunday morning classes afford opportunity for trade instruction and there are certain day schools for the combined practical and trade instruction of young men who intend to become expert workmen or foremen.

In Switzerland there is no national system of apprentice training, but a plan of continuation education embodying trade instruction somewhat similar to that of Germany, is carried on.

In Great Britain apprentice training has probably been a more important factor in supplying skilled mechanics than in the United States. One of the most notable schools for the training of employees who enter as apprentices is that conducted by the British Admiralty for more than 75 years, with marked success. The object is to train men for positions as draftmen and subordinate dockyard officers, to select the most capable for advanced training as designers, and to give an employee the largest opportunity.

In the *Journal* of the Institution of Electrical Engineers of Great Britain, vol. 53, p. 571, there is a discussion of the various types of industrial education in operation in Great Britain. The principal ones are as follows:

a A trade apprenticeship combined with evening or part-time study
b A short period of, say, a year in works, then a college course followed by works apprenticeship for college graduates
c Taking a complete college course and then a works course
d Sandwiching college and works training as in the coöperative plan frequently used in the United States
e Taking a complete works course and then a college course.

Mr. Fleming of the British Westinghouse company, describes their course for ordinary apprentices and says that:

. . . they are first carefully selected on their educational qualifications and character. After a short probational period to test their practical aptitude they are admitted to the apprentice school.

Instruction is given about five hours per week to all apprentices on company time and the firm also supplies books and stationery.

The apprentice is paid the regular rate during his school hours.

The instruction is of two kinds: general and trade. The first is a continuation of the apprentice's regular education and is important as the standard of education is low for this class of people in England.

The trade instruction is given by members of the engineering staff, including leading foremen and shop engineers. Drawings, lantern slides, and shop demonstrations are used to teach processes.

An interesting feature is an elective committee of apprentices representing the different trades, which coöperates with the school staff.

The most promising apprentices are selected as a result of their school work and are sent for one day per week to the Manchester Municipal School of Technology on company time and expense.

Another works school which has caused considerable comment is at Manchester, England. It is devoted to general education and to trade education. I quote a significant paragraph from the description:

Before a trade training in England can be effectively given it has been found necessary to lay the foundation of a general education of a deeper and more solid character than can at present be obtained in a primary school.

Is this true in the United States? Are we attempting to make skilled workmen, and losing sight of the importance of general education and intelligent citizenship?

In one British plant, which is believed to be the Vickers Company, the apprentice attends school four hours per week for four years. His general education includes 18 months of mathematics with shop applications, elementary science, that is, fundamental physics, principles of heat, electricity and mechanics. He has also free-hand drawing to relate the hand and eye. The general subjects include also civics, industrial history, written and spoken English, the laws of health and first aid.

The trade instruction begins after the above period of 18 months of general education. The students are now divided into two classes—those to follow mechanical engineering lines and those to follow electrical engineering lines. The treatment of the two is quite similar and only one will be described.

Six months are devoted to the development of mechanical principles, after which the groups are divided into some 12 trades and are taught the principles of their trade with demonstrations by expert foremen.

Boys meet their foreman in the school room and there discuss with him in class matters of trade practice. This is of the most healthy character, and is doing much to remove that natural diffidence which boys normally experience in approaching their foreman upon such matters.

The lecturing staff at the works school is composed of half-time lecturers all of whom are works engineers. Mostly university graduates volunteer their services.

This association of future leaders with future workmen and foremen, superintendents, etc., is *valuable*. These advantages belong only to works schools.

During the last two years a unique development has occurred. The main body of apprentices is self-governing. Each class elects one of its number to represent its interests and these come together once a week and form an apprentice council. The Council has a chairman and secretary. Council organizes social functions and acts as an apprentice tribunal.

In the latter capacity it has already done good service. It has settled minor differences, and arbitrated in such cases with more satisfaction to apprentices than could have been given by any other method.

Apprentice Training in the United States

While the number of apprentices in proportion to the number of skilled workmen may be less today than in the past, the training of apprentices is an important factor in some of our industries—in railway motive power, in the metal trades and to a lesser extent in other fields. There are two classes: first, those who have had a grammar-school or a high-school education, and, second, special apprentices who are graduates of technical colleges.

The practice of one of the electrical companies will illustrate a typical plan for the first class. Apprentice trade training is given to prepare draftsmen, patternmakers, foundrymen, machinists, toolmakers, electricians and junior engineers.

Applicants are first accepted on probation for a period of three months.

At the completion of each month of the probation period their names are brought to the attention of the Trades Apprentice Committee, at which time their record is reviewed for the purpose of determining their aptitudes and characteristics. At the completion of the third month a definite decision is made by the committee as to whether the young man shall be placed on the course, recommended for a regular position in the organization where they can be under further observation, or released from the company as unsuited for the work.

When the probation period is completed an agreement is entered into between the company and the apprentice and his parents, and outlining what the company expects of the apprentice during his course and what the apprentice may expect from the company. The apprentice is then placed in a special training department in the factory where he receives preliminary instruction in the operation of various machine tools under the direction of especially qualified instructors.

The training department turns out a product the same as other departments in the factory, but it is particularly equipped to take care of young men who have had no previous experience on machine-tool operation. Supplementing the shopwork each apprentice reports to the trades apprentice school four hours per week. Two hours of instruction are given up to blueprint reading, sketching and mechanical drawing, including tool design. The other two hours per week are devoted to economics, science and a study of shop problems, including the application of mathematics to manufacturing operations.

After several months' experience in the apprentice training the young men are placed in the different manufacturing divisions on various kinds of work to thoroughly acquaint them with our products, organization, personnel and policies. As they progress through the course more difficult assignments are given them, both in the shop and in the trade apprentice school.

Students are "upgraded" and promoted and wage scales determined by careful supervision and records of performance, character and habits. The drafting course and junior engineering course are open only to high-school graduates. Advanced technical training is available for all trade apprentices in an evening school supported by the industry and in evening classes at technical institutions in the city.

Special Apprentice Courses

Special apprentice or graduate-student courses for college technical graduates are given by an increasing number of corporations. These courses are designed for the dual purpose of acquainting the student with the processes and product of the company and of finding the line to which each student is best adapted. The method frequently employed is to devote one year to practical experience in design, assembly, and testing with weekly conferences with and

instruction by the engineers and executive staff. After the particular line of work for each to pursue is decided the subsequent training is more intensive in that particular line and leads to design, research, testing, and sales or executive positions.

The motive-power departments of the Pennsylvania and New York Central systems have had courses for college graduates which have led students in the past to enter a few of our technical schools that provided special training preliminary to service in the motive-power departments. This plan was successful until the railway shop unions were able to obtain an agreement with the director of the railroads under government control that college graduates should not be so employed. This was not only short-sighted but unfair to college-trained men and to the railroads.

The general apprentice courses are effective where they are employed in training skilled mechanics and in preparing men of ability to become foremen and minor executives. The special apprentice courses serve as vocational guides and acquaint the student with the product, methods of manufacture and business ideals and practices of the company. There is no doubt of the value of such courses. The objection is raised that they are too long and that college students avoid apprentice courses, some of which are four years in length. This objection could be partly met by a coöperative plan in which the industries accepted undergraduates as apprentices, employing them before graduation for one or two summer periods of three months.

GENERAL INSTRUCTION FOR SKILLED AND SEMI-SKILLED EMPLOYEES

This country has developed types of instruction unknown abroad, adapted to the needs of mechanics, electrical workers and a wide variety of other trades unknown in other countries.

Correspondence Courses. The English type of extension lecture course was first introduced here about 1891 and it soon replaced the old lyceum. This variety of extension instruction was not adapted to the needs of the average industrial employee. It was soon supplemented by correspondence courses, and private correspondence schools for instruction in a wide variety of subjects sprang up and flourished. A number of them are still active—one claiming to have a million students enrolled. The public and private correspondence schools have done a great service for those who had the ambition and ability to pursue the work.

The Pennsylvania Plan. Classes are organized in the shops, power plants, and wherever a group of men or women desire to study industrial or engineering subjects. A teacher is selected from the executives, who knows by experience the problems of the machine shop, boiler room or other parts of the industry in which the group is employed. The subject which they desire is prepared in special form adapted to the type of instruction.

The class meets with a teacher once or twice a week in a room equipped and provided by the plant or in the city schools or in the Y. M. C. A. The time is usually at the close of work hours and before the workers go home. An increasing number of companies allow a part or the whole instruction to be given on company time. Some pay the cost of lessons, drawing materials and instruction as a bonus to those completing the course satisfactorily.

Supervised Home Study. A plan devised where the group desiring a subject is too small to warrant the expense of an instructor or where an isolated employee desires an advanced subject, is to provide correspondence lessons as is usual but have an instructor or supervisor in reach of such student, who may be consulted at a stated place and time to answer questions and explain difficulties. The answers are sent to the college teachers for grading.

The Engineering Extension Division of the Pennsylvania State College organizes the three types of instruction, viz., correspondence and extension classes and supervised home study, for over 7000 men and women employed in the industries of Pennsylvania. The subjects cover a wide field which is constantly being extended. Special lesson material has been and is being prepared; or the texts produced by the University of Wisconsin Extension School are used. Courses for college credit in engineering are given by both institutions mentioned under proper restrictions.

Coöperative Courses for Technical Students. It is not the purpose of this outline of the various types of industrial education to discuss college curricula for technical students who expect to enter industrial or engineering occupations. A word concerning the various forms of coöperation between the schools of technology and the industries, however, seems appropriate.

For years the industries have employed college men during the summer vacation, or for a half-year or more before graduation. The coöperation was at first more or less loose and informal, with a growing tendency to require reports from the industries and from the students on the quality of work done, its character, and the comments of the "boss" on the human qualities of each student.

The first systematic attempt was that made by the University of Cincinnati, under Dean Herman Schneider, in 1906. The plan is for the student to spend two weeks in pursuing his studies in course and the following two weeks in a shop somewhat as an apprentice learning a trade. Thus alternate periods are devoted to class and to practical work. Groups alternate so that the same subject is repeated in class and in the industry. The student is paid a wage increasing with his practical experience.

The plan was first applied to students in mechanical engineering and later to civil engineering students and those following business pursuits. It took about five years of eleven months each to complete the course, and it was stated that "present coöperative students who have been at the University of Cincinnati four years are of more value to the industries than the ordinary college graduate who has had a four-year course and two or three years as a special apprentice.

A number of other institutions have adopted a coöperative plan differing only in the length of the period spent in the class room between periods in the shop or in other details. The plan has certain merits now well recognized.

The Massachusetts Institute of Technology has established a course in coöperation with the General Electric Company at its Lynn, Mass., works which was described in detail by Prof. D. C. Jackson and M. W. Alexander at the May, 1921, meeting of the A.S.M.E. in Chicago.

Under this plan the student pursues two years of the regular course at the Institute as heretofore. At the close of the sophomore year, the summer period of 13 weeks is spent by all those accepted as coöperative students at the Lynn Works of the General Electric Company. The succeeding terms of 13 weeks each are spent alternately by one-half the class at the works and at the Institute except that the last term is pursued at the Institute by all students. The coöperative course is five years of eleven months each in length, a month of vacation following each eleven months' term.

Foremanship Training. Probably no educational factor in industry has been so emphasized by the war as the need of special training for the foreman. The character of his job has changed and his importance has increased. He determines certain factors which decide whether production is on an economical or a wasteful basis. He also represents the management or may do so in the new relations with employees. He is no longer employed to "hire and fire," but to organize, assist the accounting department in analyzing costs and reducing them, to coördinate more closely with other departments and to maintain good personal relations with his men as the representative of the management.

Numerous plans of instruction have been prepared to be given in short intensive courses of two weeks, or by correspondence, or by weekly works meetings of the foremen in a plant. Quite frequently, however, it is the management that needs to take the course in order that the importance of the foreman's job may be appreciated and in fact officials are taking new and increased interest in education for workingmen, foremen and for minor officials.

Foreman Teacher Training. Congress passed the Smith-Hughes law designed to give each state a specified amount of federal funds if matched by an equal appropriation of state funds for the purpose of training industrial teachers. This has been interpreted as applying to foremen who may be given "foreman teachers' training." The good foreman has always been a teacher, but recent industrial conditions and the numerous coöperative schemes for training secondary-school, high-school and college students in industry have magnified the foreman's importance as a teacher. Many are inclined to smile at the idea of formal training for the foreman teacher, but the fact is that the act offers opportunities for practical training of foremen in the art of teaching that may have an important effect on the loss of material, human effort and wages in poor work or retarded production.

It is a wise industry which utilizes every honest strategy to prepare it for world competition. If the Manufacturers' Association were to confer with the Federal Board for Vocational Training which administers the Smith-Hughes funds and approves courses, a much more valuable training might be devised.

The Young Men's Christian Association has for years conducted courses in mathematics, drawing, auto mechanics and other subjects of service to those employed in the industries and has aided thousands of young men to get a better knowledge of their daily job. Kindred organizations are doing likewise.

Conclusion

There are numerous demonstrated educational aids to the worker, and whatever helps him will improve industry and society at large. Neither our public-school authorities nor the industries have fully realized the stabilizing value of practical education. The reduction of waste and the increase of efficiency in production are matters of education of which both the employer and the employee have need.

Furthermore, our educational work in the industries has been mainly to help the man in his daily job. We need to look farther ahead and use sound pedagogical methods in presenting to the employee the principles of economics, of simple finance, of factory operation and company policies. Some improvement in our industrial relations is possible by the use of the simplest educational principles heretofore largely ignored.

Education and Training on Railroads

By D. C. BUELL,[1] OMAHA, NEB.

THE education and training of railroad men is a subject which has received considerable attention from railroad executives for many years. The history of pioneer railroad-development work in this country forms one of the romances of the new world. Less than 100 years have elapsed since the first American railroad was projected, and the subsequent development carried with it those possibilities that attract men, both young and old.

In the early days the whole railroad was a school. Home boys importuned the agents of the railroad to be allowed to learn telegraphy and station work. It was a privilege to be allowed to ride on an engine or on a train so as to learn to be a fireman or a brakeman, or to help switch cars in the yard or truck freight in the freight house, or even to work in the track gang or around the engines in the roundhouse. There was always a trained man ready to step into almost any minor job on the railroad and handle the work connected with the job successfully.

While the old apprentice systems obtaining in most shops were in effect in the railroad shops of the country at an early date, nevertheless the first educational work of a general nature inaugurated by the railroads was in connection with associations of engineers, executives, and others brought together for the purpose of adopting standards of equipment, engineering, and operation. Much of the educational work on railroads has been done through the medium of such associations, members of which in many cases had the power to pass officially on standard methods and practices presented for their consideration.

These men were confronted with standardization problems because of differences of gage of the railroads, the necessity for transferring freight and passengers from one road to another, etc. Their deliberations and conclusions have made possible our unified transportation methods of the present day.

New Educational Requirements of the Roads

Up to the last twenty years sufficient new railroad mileage was built each year so that enough new positions were created to make promotion rapid. Today things are entirely different. There has been so little new mileage built in the last few years that opportunities for promotion in railroad service have been far below normal. Men ready for promotion have had to wait years before their opportunity came.

During the last fifteen years political interference, both state and government, in railroad operation tended to remove from the railroad executive his power of initiative and his ability to do big things in a big way. Consequently, in a manner almost unnoticed by himself or his community except in its cumulative effect, his prestige was reduced. During this same period the labor unions placed barriers in the way of their members training men to take up railroad work. Rules and restrictions forced upon the railroads and counter rules and restrictions imposed by the railroads made railroading much less attractive to the youth of the country than formerly. There is a reaction at the present time following the experiment of government control of the railroads, that would indicate the possibility of a partial return to the older conditions of management which made railroading more spectacular and consequently more attractive to youth.

Railroad executives have not been insensible to these changing conditions. Most of the railroad companies in the past twenty years have experimented with the training of apprentices in the shops. Some of the companies have very efficient apprentice systems, among which those of the Sante Fe and New York Central stand out preeminently.

Individual executives fired with enthusiasm have made sporadic efforts at educational work of almost every kind in almost every department in individual organizations, but it was not until about 1905 that a comprehensive plan of educational work for a railroad organization was seriously considered.

Basic Efforts in Educational Work

At that time the late E. H. Harriman called on the executives of the various lines under his control to work out some plan of educational work which would provide opportunity for ambitious employees to increase their knowledge and efficiency and fit themselves for promotion.

On the Southern Pacific Railroad, under the leadership of Mr. Kruttschnitt, a plan of training students in railroad operation was evolved which was in effect for a number of years. Young men selected for this training were given a four years' course of directed practical work to give them experience in the various departments of the railroad and to fit them for supervising positions when their period of training was completed. This plan, like any other new plan, had its faults as well as its good features. The fact that it is no longer followed is due to lack of placement opportunities rather than to a failure of the system per se.

Following the lead of the Southern Pacific, the Union Pacific Railroad Company in 1909 organized a Railway Educational Bureau on much broader lines than the Southern Pacific's plan and with an entirely different objective.

The Union Pacific idea was to offer to every ambitious employee in the service an opportunity to increase his knowledge and efficiency and place himself in line for promotion. In order to make the service equally available to all employees instruction was offered by correspondence.

In building up this Union Pacific educational plan it was necessary to prepare practical lesson texts on almost every phase of railroad work. The problem of preparing such texts for all classes of employees involved the expenditure of several years' time and of a considerable number of thousands of dollars. The response of the employees to this educational opportunity was greater by far than had been anticipated. There were as high as thirty to thirty-five per cent of the employees of the Union Pacific enrolled as students under this plan.

Operation of Railway Educational Bureau

As an example of the operation of this plan, track laborers were given opportunity to study those things which they needed to know to become successful section foremen. Not only actual problems of track work but other subjects such as a working knowledge of the time table and the book of rules, a non-technical knowledge

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concerning the operation of signals, instruction concerning emergency repairs to the telegraph line, instruction concerning the operation of track motor cars, instruction about such uses of concrete as might be a part of a section man's routine of duties, a thorough drill in section foreman's accounting for labor and material, etc., were offered them for study. In other words, the Bureau furnished to employees practical information about their duties and the duties of the positions ahead of them that would assist them to become more efficient and place themselves in line for promotion.

Other railroads interested in this educational work undertook the problem of working out similar service for their employees. A start was made on the Chicago & Great Western and on the Pennsylvania to establish similar educational work, but the time required to prepare the texts and the considerable cost involved in inaugurating the plan seemed to prevent other companies from going very far with the idea.

The Union Pacific educational work was extended to other Harriman lines, including the Illinois Central and the Central of Georgia. Plans were then made for extending this educational service to all of the Harriman lines, but the demand for this kind of work all over the country was such that Harriman line officials in conference decided to turn over the work to the author, who had originated and directed the plan, and thus made this educational service general in its nature and available for any and all railroads interested.

Since 1913, the Railway Educational Bureau with its office at Omaha, Neb., has functioned as a semi-commercial institution coöperating with any railroad management interested in offering educational opportunities to its employees. At the present time this Bureau is coöperating with nearly 100 railroad companies, representing well over one-third of the railroad mileage of the United States. Interested employees pay a nominal fee for the service, the railroad companies making the collections for the Bureau in the same manner they do for insurance companies, watch companies, board, etc.

While this Bureau has provided the railroads with a comprehensive educational plan available for their employees, changing conditions require that much more than this be done.

EVEN BROADER SOLUTION MUST BE SOUGHT

Old methods of apprenticeship no longer function. There must be new methods inaugurated for training new employees before inducting them into the service, for the training of foreigners and those with educations too limited to allow them to study by correspondence. Then, too, there is needed special training for employees selected for promotion to minor supervising positions before they actually take up their work of supervision.

A number of prominent railroad executives are giving careful thought to methods by which the educational necessities outlined in the preceding paragraph may be accomplished in a practical manner.

There is also needed, some method of keeping railroad employees informed of current problems, changes in standards, new methods and practices.

The Railway Educational Bureau at the present time is coöperating with the Society for Visual Education in Chicago, in the working out of a plan for a library of railway moving-picture films which will be available for all of the railroads in the country on a distribution system similar to that in effect through film exchanges to the motion picture theaters. This plan presupposes the purchase by individual railroads of projection machines which will be located at division points, general offices, etc., so that weekly programs of educational pictures can be furnished for employees and their families.

It is realized by railroad executives that the whole subject of railway educational work ties up with two other very important problems, one the employment of men and the other, directed personnel work following employment.

It is the belief of some of those who have made a study of this subject that the trend of thought in the railroad world will lead to the adoption of a centralized office to which railroad executives can go for aid in educational and personnel problems. One of the functions of this centralized office would be to prepare educational matter suitable to, and available for, the use of the railroads. This centralized office should handle the railway library of moving-picture films, and should also coöperate with individual roads in working out individual educational problems in connection with the training of new employees, apprentice training, intensive training for men selected for minor supervising positions, etc.

DISCUSSION ON EDUCATION AND TRAINING

Dr. Ira N. Hollis,[1] Past-President A.S.M.E., emphasized that the need is to train men not only for high efficiency in the industries, but also for greater satisfaction with their work. The inevitable consequence of the latter would be that their spare hours would be usefully occupied in those things that tend to the greatness of our country. He hoped that the A.S.M.E. as it gains in opportunities and progresses in influence, might have the foresight to take a hand in this most important question before the industrial world today.

Dean A. A. Potter[2] thought that in industrial education, too little attention had been paid to the talents of the learner.

Prof. A. L. Williston[3] while agreeing with the authors of the papers that progress has been made in industrial education, contrasted what has been done with the need that exists in all the different lines of industry today. He criticised the industries themselves for making almost no effort to supply this need.

He hoped that the Society would go into this matter with a considerable degree of seriousness, and that it would have vision enough to see that back of this is a contribution comparably greater than any other it can make to the profession and to the country.

To J. A. Randall[4] it seemed that since industry wants individuals trained more definitely for the job, it is necessary to have more definite conceptions of the duties to be performed in the industries.

In addition, employees should be trained in company policy, in attitude toward the company, the community, and society.

The problem of industrial training is so large that no single industrialist or group can solve it, and he suggested that the Society join with other organizations in improving courses, which so far have given the means of getting a living without conveying the power to live a life.

Edward Robinson[5] gave a few vital statistics showing just what fraction of the population the problem in hand applied to, and he, in turn, considered the committee was on the right track and hoped the Society would support further work.

L. W. Wallace[6] thought that much could be done through the Federal Board of Vocational Training if the engineer-citizens of the country would take a greater interest in its work. He said that an engineer could, with advantage, be appointed on the Board.

C. B. Connelly[7] emphasized Mr. Wallace's statement. This Society stands for education, if it stands for nothing else, and it is the duty of the Society to take up this important work. We have an engineer in the cabinet—the first since the time of George Washington, and the engineering point of view is being incorporated into government matters. Now, therefore, is the greatest opportunity for success.

A. B. Clemens[8] contributed a written discussion of both papers. His discussion of Dean Sackett's paper detailed the work of the correspondence schools under contract or agreement with industrial concerns for the instruction of employees, and his discussion of Mr. Buell's paper supplemented this information with a review of the work of the correspondence schools with the railroads.

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Avoidable Waste in Car and Locomotive Operation

By WILLIAM ELMER,[1] ALTOONA, PA.

The average freight locomotive travels less than 60 miles per day. It spends about half of its time either in the hands of the transportation department moving trains or ready to move them, or in the hands of the motive-power department being repaired and prepared. There is naturally avoidable waste in each department, and questions which may accordingly be asked relate to whether the engines are properly loaded and properly used. The present paper outlines the procedure for determining this, and one of its several appendices gives a method of working out the most economical tonnage for loading the freight engines of any division, based on actual practicable performance in everyday operation. The treatment considers the value of the locomotive, taking account of interest, depreciation and taxes; the relationship between straight-time and overtime rates for road crews; the quickening up of the time of the trains by a reduction of tonnage and the increase of the time the crews are on duty by an increase in tonnage. When these matters have been sufficiently studied in the light of the recorded facts, the question relating to proper loading can be intelligently answered.

The author discusses avoidable waste in the operation of cars under three heads: (a) Their utilization in the hands of agents, shippers and consignees; (b) their handling and dispatchment in yards and on the road; and (c) their repair and inspection.

Things contributing most to the reduction of waste in car and locomotive operation are coöperation and teamwork. If a division superintendent can be assured that everything is being done that can be done to have every available engine in service that can be put in service and that every engine dispatched is being loaded to the maximum number of cars it can economically haul, then he is assured of an economical performance and an avoidance of waste in the operation of both locomotives and cars.

LOCOMOTIVES, the first of the two divisions set forth in the title, are classified into major groups as-freight, passenger, shifting and work locomotives. There are 65,000 locomotives on the railroads of the United States and half of them are in freight-train service. Thirty-two thousand and eighty locomotives earned a freight revenue of $4,325,078,866 in 1920, or an average of $135,000 per locomotive per year. Each engine made an average of 59.3 miles per day or 1800 miles per month. The average freight engine earned for its owners $370 per day or $6.25 per mile run. This is at the rate of $15.40 per hour or about 26 cents per minute. The striking thing in the group of facts above presented is the figure of 59.3 miles per day made by the average freight locomotive. How can we excuse an average mileage for all the freight locomotives in this country of less than 60 miles per day? We can picture the average freight locomotive rolling along the rails at 15 miles per hour and that means less than four hours out of each twenty-four actually moving trains. The locomotive spends its entire time either in the hands of the Transportation Department moving trains or ready to move trains, or in the hands of the Motive Power Department being repaired and prepared. Roughly we may say that the engine is in the hands of each of these departments about half the time. Of course there is avoidable waste in each.

Taking up first the Transportation Department, there are two broad inquiries which may be made: (*a*) Are the engines properly loaded? (*b*) Are they properly used? Assuming that suitable engines have been furnished the Transportation Department, or taking the engines on any division as we find them, how are we to know when they are properly loaded? If a dynamometer car is available, road tests may be run to determine the drawbar pull of the engines and to measure the resistance of trains of various make-ups on the ruling grades at the desired speeds. In the absence of this facility it may be desirable to outline the procedure.

A—Are the Engines Properly Loaded?

A track chart of the road is necessary, giving the distances from the starting point to the beginning and ending of each curve and tangent, with the degree of curve, and elevations of points where the grade changes. With these data a true profile may be plotted, showing the elevations above sea level and the actual grades; but this profile will not be fully representative of the resistances encountered by moving trains until it has been transformed into an equivalent compensated profile by superimposing the curve resistances on top of the grade resistances for each direction of traffic. We can imagine a level railroad so full of sharp curves that a very considerable resistance would be experienced by a moving train. Many experiments have been tried in an effort to find how much resistance various curves offer to a moving car, and we will take 1 lb. per ton of 2000 lb. per degree of curve. The resistance due to grade is fortunately an exact mathematical quantity—20 lb. per ton for each 1 per cent of grade. Therefore each degree of curve offers the same resistance as a 0.05 per cent grade. A 6-deg. curve had the same resistance as a 0.3 per cent ascending grade. A grade which is climbing upward at the rate of 26.4 ft. per mile or 0.5 per cent and has in it a 6-deg. curve, or 955-ft. radius, will therefore have superimposed on the true grade of 0.5 per cent the equivalent resistance of a 0.3 per cent grade due to the 6-deg. curve, or a total equivalent grade of 0.8 per cent. Of course, to a train coming down this hill the equivalent grade would be the difference between these values, or 0.2 per cent.

Having determined the equivalent grade, it will be necessary to decide whether it can be operated as a momentum grade or not. If the length of the grade or other physical conditions on the approach prevent attaining any considerable speed, the dead pull of the locomotive will have to be depended on to get the train over. The tractive power of a locomotive is readily calculated from a very simple formula where p is the boiler pressure in pounds per square inch by gage, d the diameter of cylinders, l the length of stroke and D the diameter of the driving wheels, all in inches. For a simple two-cylinder engine, tractive power $= 0.85pd^2l/D$. When a locomotive is moving, some of its tractive-power effort is used to overcome friction of the engine and tender, and on a grade some more is needed to lift its weight against gravity, and at speeds of more than six or eight miles per hour the boiler becomes a factor in its inability to furnish enough steam to follow the pistons with full pressure under long cut-off conditions, so that some more complicated formula becomes necessary in the calculation of the tractive power required for moving trains. Besides the resistances due to curves and grades, trains are affected by journal and flange friction, wind, rolling resistance, temperature, etc.

It is a well-known fact that trains cannot be loaded on tonnage alone. One hundred empty cars weighing 20 tons each would be a 2000-ton train, and might overload an engine to the stalling point, whereas the same engine on the same grade would handle twenty-five 80-ton cars with no trouble. The number of axles is the important factor, and in order that a long empty train may have the same resistance as a short loaded train, it is necessary to use a factor for each car known as the adjustment factor, and this factor will vary with the different physical conditions met with on different divisions.

Having discovered the adjustment factor for any given division, and knowing the principal types of freight engines in use on that division, it is well to construct tractive power-speed curves for the various engines, and plot on the same sheet adjusted-tonnage train-resistance curves on various level and compensated-grade tracks, so that the intersection of the tractive power curve with any given grade will show the speed that could be maintained with a full-tonnage train on that grade.

After having completed the above described investigations and having before us the equivalent profiles and the speed curves on various grades, we can lay out a schedule of the running time between the various towers, adding the necessary time to cover the initial and final terminal delay, water stops, coal and fire-cleaning stations, interference from passenger trains, etc., and bearing in mind the overtime limit based on a speed of 12½ miles per hour for the distance between terminals and the time the crew is on duty.

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Now comes the crux of the whole matter. After the tonnage has been established, what are the results on the road? Do the trains lose so much time sponging or setting off cars with hot boxes, or draw heads out or brake rigging down, or due to interference from other trains that they cannot get over the road without excessive overtime? If the dispatching and terminal and road supervision are all that they should be and a record has been made for a sufficient period from which may be drawn reliable conclusions, we can determine whether the overtime is excessive—in which event the tonnage should be decreased—or if the majority of the trains get over the road within the overtime limit, then the tonnage should be increased. Appendix No. 1 contains the description of a graphical report showing each morning the performance of each of the previous day's trains, both slow and fast freight, plotting the time on duty from called to relieved against the percentage of the full tonnage loading of the engine utilized. This gives the train master, road foreman of engines and superintendent a review of the preceding day's operations, and any falling away from the standards set up on the part of the subordinate officials whose duty it is properly to load the trains is quickly brought to light. In Appendix No. 2 is given the method of working out the most economical tonnage for loading the freight engines of any division, based on actual practicable performance in everyday operation. The treatment considers the value of the locomotive, taking account of interest, depreciation and taxes; the relationship between straight time and overtime rates for road crews; the quickening up of the time of the trains by a reduction of tonnage and the increase of the time the crews are on duty by an increase in tonnage. When these matters have been sufficiently studied in the light of the recorded facts, we are in a position to answer the question, Are the engines properly loaded?

B—Are the Engines Properly Used?

So far as the Motive Power Department is concerned, it is important to have reliable reports which present promptly to the responsible operating officers, on the succeeding day if possible, all the pertinent facts concerning the performance of the locomotives available. These reports should cover not only the utilization made of the serviceable locomotives but also of all those laid off for repairs, both in the roundhouses and the back shops. The more promptly the work is done the more engines will be available for service and the smaller will be the number required to be purchased and to bear interest and depreciation charges. To this end the facilities at the engine terminals should be ample to inspect promptly the incoming locomotives and send the reports to the dispatcher, who can at once call a crew in case the engine has only light work which can be completed by the time the crew reports. The fire-cleaning pits and facilities for handling ashes, coal, sand and water should be in duplicate at important points, and at one well-known freight-engine terminal it is possible to clean the fires and prepare for service 400 locomotives per day. Hot-water systems for washing and filling boilers save time, and drop tables or unwheeling hoists should be provided for handling driving wheels, spring rigging and driving-box repairs. Ample jib or overhead cranes should be installed in all important enginehouses, as the rods, pumps, pistons, smokebox fronts, etc., of modern locomotives are now so heavy that mechanical appliances must be used to reduce the cost of handling and save time in running repairs. The enginehouse referred to above at times furnishes the power for ten eastbound trains in two hours and at the same time ten to fifteen engines an hour for westbound trains. An operation of this magnitude requires close supervision in order that waste of power and loss in efficiency may be avoided.

CARS

The avoidable waste in the operation of cars may be considered under three heads:

a The utilization of cars in the hands of agents, shippers and consignees

b The handling and dispatchment of cars in yards and on the road

c The inspection and repair of cars by the maintenance of equipment department.

A—The Utilization of Cars in the Hands of Agents, Shippers and Consignees

The committee of engineers appointed by Secretary Hoover some months ago to investigate waste in industry made a most amazings report. They undoubtedly gave this question careful study and the report that they made brought out the fact that the production of this country could be immediately increased about 50 per cent by the full utilization of existing facilities. The managements of the industries of this country are acknowledged to be the most efficient known and the railroad managements are no exception, therefore it is the more surprising to find such disparity between the present efficiency and the attainable.

So far as the railroads are concerned, one great means that suggests itself is the increased use of cars in the hands of agents and shippers, which necessarily involves the promptness with which they are loaded and unloaded and the extent to which they are loaded, i.e., that the maximum loading be secured for the car in the minimum time, etc.

Maximum car loading is a matter of dire necessity during periods of car shortage. If is also very essential to the economic conduct of transportation. During recent months the necessity for conserving cars has been decreased by the small volume of tonnage handled by the railroads; the requirement of economy is more urgent than at any time within the past eighteen months. This is all a matter of education and a spirit of coöperation on the part of the public. When the railroads had more business than they could handle the local officers were being urged to get out and interview the shippers, the underlying idea being to secure their coöperation, especially in the matter of better and heavier carloads. Distinct improvements were noticeable and the effort proved its worth. With the slump in traffic the "drive" lost its punch and there is a tendency on the part of the shippers and railroad men alike to let down in their efforts to secure maximum loading. This "line of least resistance" method is resulting in considerable less-than-capacity loading.

It is a fact, not generally recognized, that car loading affects the cost of railroad operation very seriously, not only because the paying load may be a small percentage of the gross train load, but also because lightly loaded cars require more tractive effort per ton than heavily loaded cars; e.g., the average weight of a car is from 15 to 20 tons while the average weight of all commodities is averaging approximately 27 tons. The load of the car itself must be hauled with every movement of the contents and requires as much tractive effort on the part of the locomotive per ton to move this weight as it does for the contents, therefore the importance of keeping the percentage of lading to total weight as high as possible is self-evident. This question has assumed a very different aspect to the shipper since the passage of the Transportation Act, which stipulates that the rates must be sufficient to earn a fixed return on the value of the properties. Any waste due to the light loading of cars adds to the operating cost and thereby to the rates necessary to earn the specified return. The shipper therefore has a new interest in effecting economies of transportation and can contribute to that end most effectively by coöperating in the heavier loading of cars.

During the period February to August, 1920, the average loading of cars in the United States increased from 28.3 tons to 29.8 tons per car. As a result of this coöperation on the part of shippers there was a gain of carrying capacity equal to approximately 112,500 cars. From time to time we have noticed by the public press that there is a shortage of 100,000 cars in the United States, and as such is considered a serious matter to the trade of the entire country, it is very apparent that the simple feature of increasing the load in each car 1.5 tons more than liquidated the alleged shortage.

General practice permits the loading of cars 10 per cent in excess of the marked capacity. There are great possibilities in the utilization of this margin, for with many classes of loading great advantage may be taken of it to gain one car in every ten and to increase the average carload correspondingly.

There are many commodities moving which will permit of the making of trade units to correspond to the capacity of the car; this has been done with cement and other like commodities. The trade unit for cement shipments was set at 144 bbl. for a 50,000-lb.

capacity car; 173 bbl. for a 60,000-lb. capacity car; 231 bbl. for an 80,000-lb. capacity car and 289 bbl. for a 100,000-lb. capacity car. The establishment of this standard encourages the loading of cars to capacity. If this were done with flour and all similar commodities great assistance might thus be rendered to the railroads.

The agent through close association with shippers is in the best position to encourage maximum loading. It is often decidedly hard to convince shippers that they are not loading their cars to cubical capacity. This is particularly true of the coal operators. The best means of producing convincing evidence of the empty space in a car is to show the shipper a photograph of the car which will speak for itself, and we have found a kodak to be a most helpful instrument in increasing the tons per car. The cars may easily be intercepted and photographed at scales or in classification yards.

The prompt release of cars under load is a large factor in the efficiency of the car. Most shippers and consignees are reasonable in this respect and will give us their best efforts if the matter is handled with them in a diplomatic way. After urging the shippers and consignees, the railroad then has a very important part to play by the prompt movement of cars, whether loaded or empty; it being purely psychological that after urging the shipper or consignee and then failing on our own part would necessarily breed antagonism.

B—The Handling and Dispatchment of Cars in Yards and on the Road

After cars have been loaded and waybills furnished by the agent to transport freight from point of origin to destination, it becomes the duty of the train master to arrange for movement and delivery with the least possible delay consistent with economical operation. This necessarily involves good organization and effective supervision to accomplish proper movement through yards and over the road. Normally cars are weighed at the first track scale encountered after departure from shipping point, for the purpose of ascertaining proper charges for transporting freight which involves the agent at the scales, who is responsible for securing accurate weights as a basis for applying the freight charges. As a rule, the weighing is performed in a yard consisting of receiving and classification tracks. Trains arriving in the receiving yard are subjected to inspection and minor repairs to insure safe movement over the road between terminals, sending to the repair yard any bad-order cars that must be "shopped" for this purpose. After inspection and repairs have been completed, the train is prepared for switching from receiving yard to classification yard, which process requires car markers to chalk-mark cars for their respective classification tracks, according to destination and routing, also furnishing corresponding switching lists for the conductor in charge of switching crew, and switchmen who operate switches leading into the classification yard. Yard locomotives and a force of trainmen are required to switch trains into the classification yard at proper speed for accurate weighing at points where cars pass over a track scale; also requiring brakemen, commonly designated as "car droppers," to ride cars into the classification yard and control them by use of hand brakes to bring them to a stop at the proper point and to avoid damage by impact with preceding cars standing on track.

The train from receiving yard has now been distributed on various tracks in the classification yard, usually from ten to thirty tracks, depending on the size and importance of the yard operation. The original train having thus lost its identity, following trains, classified in like manner to the same tracks, are required to assemble cars that will comprise new trains to be dispatched when the required tonnage is accumulated. A variety of conditions arise at this stage of the operation that seriously influence the time consumed by cars enroute to their destination, which may necessarily be repeated from one to many times between the originating point and destination of cars, depending on the distance and the territory over which they are moving. The time required to assemble sufficient tonnage for a train in the classification yard is very largely dependent on the steady or intermittent arrival of trains in the receiving yard; also on the hauling capacity of road locomotives used on trains dispatched in the same direction, which may be 35 or 50 cars from one yard and 100 to 115 cars from another yard for the same class of locomotive, depending on the ruling grade of the division over which trains are being hauled.

In this connection another primary cause of delay in assembling trains in the classification yard is to be found in the usual number of classifications imposed upon certain yards for the convenience of connecting divisions to meet their requirements for various reasons, but primarily due to inadequate track and switching facilities. So-called "prior classifications" are also a source of yard delay at the point where they are assembled, but the time thus consumed is presumably offset by saving in time at the next yard or terminal point where such trains are kept intact and delivered to the division in advance thereof without reclassifying, which means an actual saving in the aggregate time consumed from shipping point to destination, also in operating expenses. Therefore a considerable portion of yard delay is beyond control, owing to prevailing conditions that cannot be eliminated. However, there is ample opportunity for minimizing yard and road delays to train movement by employing the best operating methods, maintaining sound organization and efficient supervision.

Time consumed assembling tonnage for heavy trains to be hauled by large types of locomotives over comparatively level grades may be viewed by some as a contributory cause of "avoidable waste in cars," but it should be recognized that doing so, reduces the number of engine and train crews and locomotives required to haul a large volume of freight, which means economical operation.

C—The Inspection and Repair of Cars by the Maintenance-of-Equipment Department

When trains are hauled over the road certain defects develop, and by the time they reach the terminal of a run a certain portion of the cars, say 3 to 5 per cent, must go to shop for repairs. The cars from the time last inspected until they go to the industries or mines to be loaded and return, develop many defects due to stress and strain of service, and consequently they have to be shopped when reaching the nearest terminal.

There are three distinct classifications for shop cars: light, medium and heavy. When an inspector discovers a defect which he cannot correct, he applies a bad-order card, and places it in a conspicuous location on the car. These cards are placed in one of three positions: vertical, horizontal or at an angle of 45 deg. A card placed in a vertical position indicates light repairs; horizontal, heavy repairs; and at a 45-deg. angle, medium repairs.

After the train is inspected a car marker goes along the train and marks each car with chalk and the date and track number to which each particular car is to be classified.

As already stated, the classification yard consists of a number of tracks for the various classifications; a certain number of these tracks are set aside for shop cars, some tracks for light-repair cars, some for medium, and some for heavy repairs. The shop cars are moved from the classification yard to the car-repair yard by shifting engines, usually at night, and the repair tracks filled up so that when the gang foremen arrive at their places of duty approximately one-half hour in advance of the commencing time for the shop forces, they can prepare their work for the day. It is their duty to see that the work is properly distributed and there is sufficient material on hand to proceed with the repairs.

After they have all the cars written up they start inspecting the work done by the men to determine if it has been properly performed, and that proper charges for material have been made. After this is completed they report out such cars as are ready to go and mark those uncompleted to be set back. The shifting crew then takes out the entire string, returning those not completed. It is the gang foreman's duty to see that any cars not completed are in such shape that they can be moved out with the O. K. cars, as otherwise there would be non-movable cars between two or three cars O. K. for service and this would hold the cars ready for movement an unreasonable length of time.

After the cars are turned out of the repair shop they are returned to the receiving yard and reclassified over the hump to be returned to service.

In order to keep a check on cars undergoing repairs, a report is prepared and sent to the different operating officials. The report

indicates the time the car is shopped, the time it is moved to the shop, the time repairs are completed and the time car is moved out of shop. By checking over this report each morning the master mechanic, superintendent or general officers can determine in a few seconds if there are any cars that are being held an unreasonable length of time.

It is the aim of the operating officials not only to see that all cars are repaired, but to have the cars repaired promptly and returned to service in the most expeditious manner.

CONCLUSION

The great secret of the entire operation, therefore, lies in coöperation and teamwork, and these can be checked by suitable reports.

The statistics which reach the superintendent's desk giving hourly, daily, weekly and monthly information are many and varied, and originate from numerous sources, but the reports scanned by the author with most interest each day are those which tell where each of the heavy road freight and passenger engines were the day before and what they were doing. There is a maxim, "Take care of the shillings and the pounds will take care of themselves." It seems to apply particularly to the railroads. Take care of the engines and the dividends will take care of themselves. Of course this could not be literally true, but there is so much involved in this "taking care of the engines," embracing as it does the time and inferentially the money spent on locomotive repairs, the quality of back-shop and engine house work performed, the proper tonnage rating, and suitable loading of engines in order to obtain the most economical road speed, the reduction of delays getting into and out of yards, the inspection and repair of car equipment, the efficiency of water stations, coal-, sand- and ash-handling plants, the organization and operation of wreck forces, the handling of local freight and work trains, in fact, almost each and every one of the thousand and one matters that go to make up a successful operation of a division. If any one of the features named above is not functioning properly, as well as others too numerous to mention, the effect will be seen in the slowing down of the road speed or a lowering of the average mileage per serviceable locomotive or a falling off in the loading efficiency. All these must be at their highest possible levels of practical performance, and when they are, a glance of the eye at the daily barometer ought to tell it, and when they are not, a few minutes' inspection of the data ought to tell why and point the remedy. The supervisors must have tracks fit for speed and service; the signal engineer must have communicating systems and signal apparatus in good working order; the road foreman must have engines properly rated and sufficient crews and supervision; the train master must have his yard and road forces properly instructed and disciplined; the division operator must have his train dispatchers and signalmen alert and intelligent; and the master mechanic must produce the power in ample quantity and fit for service. If the division superintendent can be assured that everything is being done that can be done to have every available engine in service that can be put in service, and that every engine dispatched is being loaded to the maximum number of cars it can economically haul, then he is assured of an economical performance and an avoidance of waste in the operation both of locomotives and cars.

APPENDIX NO. 1

DAILY SLOW FREIGHT-TRAIN PERFORMANCE RECORD

The record shown in Fig. 1 is prepared each morning from the train sheets and tonnage records of the previous day. Each dot or circle represents a train, its position vertically indicating on the scale at the left the percentage of the full capacity of the engine utilized, and its position across the sheet, read from the scale of hours at the bottom, shows the time the train crew was on duty. The red dots (shown in Fig. 1 as small circles) represent eastbound trains and the black dots westbound trains. The extreme left-hand dot shows a westbound train which was 99 per cent of the full adjusted-tonnage rating of the engine, and it made the run over the division in 8 hours 12 minutes from the time the crew were called to report for duty until they were relieved from duty at the opposite terminal. It includes initial and final terminal delay and this particular train made an excellent run, well within the overtime limit. The red dot (small circle) slightly above and to the right represents a 100 per cent eastbound train, 8 hours and 18 minutes from called to relieved. The dot to the extreme right shows a westbound 101 per cent train, 14 hours. It is seen at a glance that the lowest loading for that day was 94 per cent and the highest 105 per cent. The spread of the time was from 8 hours and 12 minutes to 14 hours. Fourteen runs were made within the overtime limit (of ten hours and a quarter), and no crews were relieved on account of the 16-hour law. The average of all the red dots (small circles) is shown by the red cross at A and its position shows that the average of all the eastbound trains that day were loaded to 100 per cent and the average time was 10½ hours. The black cross at B shows that the average loading of westbound trains was also 100 per cent and the time just under 11½ hours.

The black characters near the left-hand margin indicate the class of engine hauling the westbound trains, the number of cars being shown on the scale at the right, and the time from called to passing out of the yard being read on the scale of hours at the bottom. From this it can be seen that there were three trains of 100 cars each, 1 hour and 24 minutes, 1 hour and 30 minutes and 1 hour and 42 minutes getting out of the yard. There were nine trains of 115 cars each, varying from 1 hour and 12 minutes to 2 hours and 48 minutes initial terminal time. Other trains are as indicated, the total number completing their runs that day being 20. Similar information is shown for the eastbound trains by the red (dotted-line) characters near the right-hand margin, the final terminal delay being recorded from right to left and read on the scale just above; the number of cars per train varying from 90 to 105, and the time from 36 minutes to 2 hours and 6 minutes. The same sheet is also used to record fast freight trains, but these have been omitted to avoid complication. An explanation can be given on the back of any unusual conditions, undue length of time on the road, reason for relieving crews, etc. A code of symbol letters reduces the need of elaborate descriptions.

After keeping these daily sheets for several months, the location of all the red crosses may be recorded on a sheet of tracing cloth, or a composite of all the red dots (small circles) may be made on one tracing, and through the center of gravity of all the dots a curve may be drawn, and this will show for any point on the curve the average time for the trains corresponding to that tonnage loading. A similar composite of the black dots[1] will show the

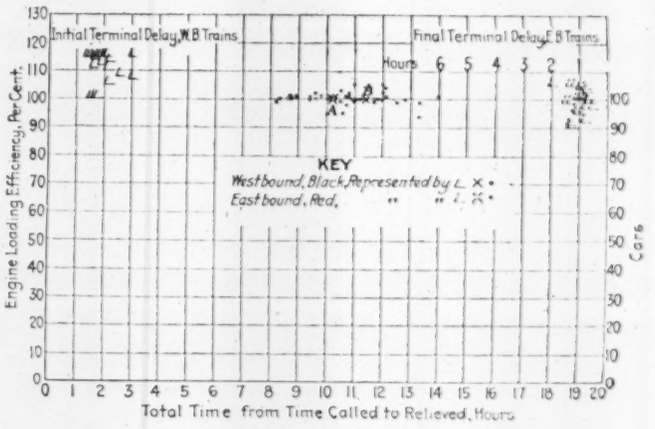
Initial Terminal Delay, W B Trains.
Final Terminal Delay, E B Trains.
Hours
KEY
Westbound, Black, Represented by
Eastbound, Red, " "
Engine Loading Efficiency, Per Cent.
Cars
Total Time from Time Called to Relieved, Hours

FIG. 1 DAILY SLOW FREIGHT-TRAIN PERFORMANCE RECORD

westbound trains. These curves are shown in Fig. 2 and are the basis of the calculations of the most economical train loading described in Appendix No. 2. Even if most of the dots and circles are concentrated along the lines of full tonnage, there will usually come days when engines are being loaded light to get them to the other end of the division to meet a heavy movement, and there are occasional mistakes of yard clerks which result in underloaded or overloaded trains which are not checked up until the conductor's wheel report is recorded at the end of the run.

APPENDIX NO. 2

THE MOST ECONOMICAL TRAIN LOADING

The curves described in Appendix No. 1 having been prepared, the data shown in Table 1 may be calculated. Column 1 gives the percentage of engine loading, from 120 per cent down to 80 per cent. The average flat tons in the eastbound and westbound trains having been recorded each day on the sheets shown in Fig. 1 and the percentage of the engine loading being also available for each day, a summary may be run up at the end of the month and a comparison drawn as to the number of flat tons per train which would correspond to a 100 per cent tonnage train. A few months of this information will settle the proper figure and this has been shown for the westbound trains at the head of column 2. This amount multiplied by the percentages in column 1 gives the tons per train in column 2. From the load-time curves in Fig. 2 may be read the average time for a westbound train loaded to 120 per cent of the engine rating, etc., and these times recorded in column 3. The summary mentioned above will also show, by extension, the total gross tons moved each day, and the average of this figure is at the top of column 4. The number of trains which it would be

[1] It is suggested that black ink be used in making the composite of the red dots and red ink for the black dots. It is much easier to see the opposite color through the thickly clustering dots of the composite, and those below the tracing cloth will not be so readily missed.

TABLE 1 MOST ECONOMICAL TRAIN LOADING

(1) Per cent engine loading W.B.	(2) Tons per train W.B. 2400 × (1)[1]	(3) Time called to relieved, hours W.B., Curve	(4) No. of trains W.B. 48000 ÷ (2)	(5) Tons per train, E.B. 140,000 ÷ (4)	(6) Per cent engine loading, E.B. (5) ÷ 7000	(7) Time called to relieved, hours, E.B., Curve	(8) Time crews on duty 1 R.T., hours (3) + (7)	(9) Total time of engine 1 R.T., hours (8)+24	(10) Engine hours, total (9) × (4)	(11) No. of engines required (10) ÷ 24	(12) Overtime hr. per train R.T. (8) − 20.5	(13) Punitive overtime, hr. per train R.T. (12) × 1½	(14) Total punitive overtime, hr. per day (13) × (4)	(15) Overtime, total cost per day (14) × 3.975	(16) Straight time, hours per day (4) × 20½	(17) Straight time cost per day (16) × 3.975	(18) Total wages cost per day (15)+(17)	(19) Value of engines at 60 cts. per hour (10) × 0.60	(20) Total engine and wage cost per day (18) + (19)	(21) Per cent engine loading W.B.
120	2880	14.18	16.667	8400	120	12.93	27.11	51.11	851.85	35.49	6.61	9.92	165.34	657.23	341.67	1358.14	2015.36	511.11	2526.47	120
115	2760	13.00	17.391	8055	115	12.11	25.11	49.11	854.07	35.59	4.61	6.92	120.35	478.39	356.56	1417.17	1895.56	512.44	2408.00	115
110	2640	12.13	18.182	7700	110	11.40	23.53	47.53	864.19	36.01	3.03	4.55	82.73	328.85	372.73	1481.60	1810.45	518.51	2328.96	110
105	2520	11.41	19.048	7350	105	10.78	22.19	46.19	879.83	36.66	1.69	2.54	48.38	192.31	390.48	1552.16	1744.47	527.90	2272.37	105
100	2400	10.77	20.	7000	100	10.21	20.98	44.98	899.60	37.48	0.48	0.72	14.40	57.24	410.00	1629.75	1686.99	539.76	2226.75	100
95	2280	10.19	21.053	6650	95	9.67	19.86	43.86	923.38	38.47	..	..	....	....	431.59	1715.71	1715.71	554.03	2269.74	95
90	2160	9.67	22.222	6300	90	9.16	18.83	42.83	951.77	39.66	..	..	....	....	455.55	1810.81	1810.81	571.06	2381.87	90
85	2040	9.18	23.529	5950	85	8.70	17.98	41.98	987.75	41.16	..	..	....	....	486.34	1917.31	1917.31	592.65	2509.96	85
80	1920	8.70	25.	5600	80	8.26	16.96	40.96	1024.00	42.67	..	..	....	....	512.50	2037.19	2037.19	614.40	2651.59	80

[1] 2400×(1) = 2400 multiplied by value in Column 1.

necessary to run to move the average day's business may be found by dividing this number of tons by the proposed tons per train in column 2 and the result recorded in column 4. The same process is followed to obtain the figure at the top of column 5 as explained for column 4 and as there will usually be the same number of eastbound as westbound trains in order to avoid running power and crews light, the tonnage per eastbound train will be found by dividing the total tons to be moved per day by the trains per day shown in column 4 and the results recorded in column 5. The total time on duty for the crews in making a round trip is shown in column 8, and from data obtained on reports described in other appendices, it has been determined that on the division under consideration, engines are off the road and in the hands of the Motive Power Department about 24 hours for every round trip they make. Consequently, 24 hours should be added to the times shown in column 8 to give the total time of an engine for a round trip as in column 9. This number of round trips made in column 4, multiplied by the number of hours per round trip in column 9 will give the total number of engine hours shown in column 10, and these figures, divided by 24 hours in the day, will give the number of engines assigned to the service as recorded in column 11.

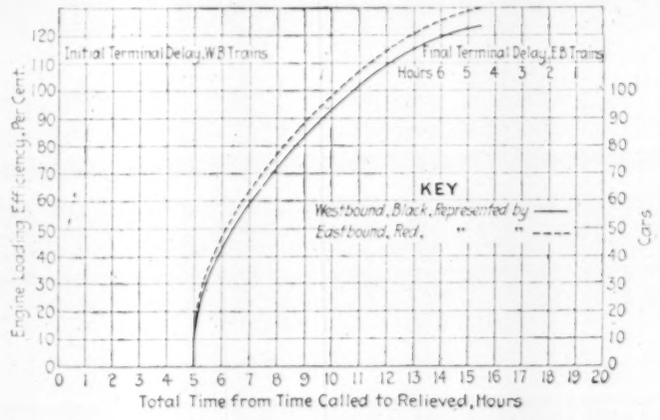
Initial Terminal Delay, W.B. Trains
Final Terminal Delay, E.B. Trains
Hours 6 5 4 3 2 1
KEY
Westbound, Black, Represented by ——
Eastbound, Red, " " ----
Engine Loading Efficiency, Per Cent.
Cars
Total Time from Time Called to Relieved, Hours

FIG. 2 TYPE OF CURVES USED TO SHOW AVERAGE TIME FOR TRAINS OF A GIVEN TONNAGE LOADING

As the average distance run by these trains is 128.2 miles and the overtime speed basis is now 12½ miles per hour, the time per trip is 10¼ hours and for the round trip 20½ hours. Consequently, the overtime per round trip is found by subtracting 20½ from the times shown in column 8, and the result entered in column 12. We now pay time and a half for overtime in freight-train service, therefore the number of hours shown in column 12 multiplied by 1½ gives the overtime hours for which we have to pay at the regular hourly rates, and these figures are entered in column 13. Multiplying by the number of trains per day in column 4, we have the total number of punitive overtime hours per day shown in column 14. The total wages paid to the engine and train crews in slow freight service and with the class of engine under discussion now amounts to $3.975 per hour, and the figures in column 14 multiplied by this sum gives the total overtime cost per day as shown in column 15. The straight-time hours per day is the product of the 20½ hours for one round trip times the number of trips in column 4 and is shown in column 16. This at the rate of $3.975 per hour gives the total straight time cost per day shown in column 17, and adding the overtime cost in column 15 gives the total wages cost per day in column 18.

Modern Mikado locomotives of the size under consideration are worth $47,750 apiece, and taking interest at 6 per cent, depreciation at 4 per cent and insurance and taxes together at 1 per cent, we have fixed charges of $5,256 per locomotive per year, or $14.40 per day or 60 cents per hour. Column 19 shows the value of the engine hours in column 10 and the sum of the wages cost in column 18 gives the total engine and wage cost shown in column 20. It will be noted that this cost is a minimum at 100 per cent loading. The limits are rather narrow and an error of 10 per cent in overloading or underloading would cause a loss of $100 per day or $3000 per month on the amount of business handled on the division under consideration.

DISCUSSION AT RAILWAY SESSION

IN opening the third session held so far by the Railway Division of the A.S.M.E. on Tuesday, December 6, 1921, Edwin B. Katte, chairman of the Division, called attention to the fact that the keynote of the Annual Meeting, the elimination of waste, was being carried out by the Division in papers relating to waste in connection with the design and operation of railway equipment. He introduced W. H. Winterrowd, chief mechanical engineer of the Canadian Pacific Railway, and now vice-chairman of the A.S.M.E. Division, who presided at the session. The papers presented were Avoidable Waste in the Operation of Locomotives and Cars, by William Elmer; Avoidable Waste of Locomotives as Affected by Their Design, by James Partington; and Avoidable Waste in Car Operation—The Container Car, by Walter C. Sanders.

DISCUSSION OF THE PAPER BY WILLIAM ELMER

Wm. L. Bean[1] opened the discussion of Mr. Elmer's paper, stating that he considered it a splendid exposition of the practical means for overcoming a loss incident to the short and inadequate use of equipment and that it presented a specific method of working out improvements. It had been his experience, he said, that locomotives which were operating satisfactorily to the extent of keeping off the delay sheet, might not be operating with satisfactory fuel economy. He had noticed on the N.Y.N.H. & H.R.R. during 1921 that the consumption of coal on a unit basis in freight service was 10 per cent less than the previous year. Part of this increase in economy was due to equality of loading, as in times of slack business trains could be uniformly loaded more easily than in busy times. He considered overloading of engines worse than underloading. He had found that many roads, in applying the adjustment factor explained by the author, failed to take account of the difference of its application on the level and on grades, as was also true of temperature adjustment, which applied, of course, only to rolling friction.

A. J. Wood[2] spoke of the importance of considering acceleration so essential in heavy passenger traffic. There was a field for development of this problem, he said. He had been interested to find how accurately schedule time can be computed by laying out speed-time curves from ordinary roadbed data.

Mr. Elmer, in closing the discussion, commented on a reference Mr. Bean had made to the importance of fuel economy, saying that he did not wish to imply that he did not consider this of importance. He would not, however, give too much attention to a slight variation in fuel economy if the loading of the locomotive were correct. Acceleration, too, was important, but was as vital in freight traffic as in passenger traffic.

DISCUSSION OF THE PAPER BY JAMES PARTINGTON

C. C. Trump[3] presented a written discussion in which he called attention to the application of the uniflow engine to locomotives. Prof. Johann Stumpf, by using the energy of exhaust steam with an ejector action, had been able to lower the back pressure in the cylinder by 4 or 5 lb. per sq. in., especially at heavier loads. Thus both the length and diameter of the uniflow cylinder for a given

[1] Assistant General Mechanical Superintendent, N.Y.N.H. & H.R.R.
[2] Professor of Railroad M.E., Pa. State College, State College, Pa.
[3] Fuller Lehigh Co., New York, N. Y.

drawbar pull had been reduced. In addition, a steadier draft had been attained. A smaller boiler is required but a larger superheater, because of reduced flue temperatures. Data from Europe indicate that with 700 to 800 lb. pressure in a compound uniflow engine, a well-designed condenser, economizer, etc., the economy and simplicity of a Diesel locomotive might be equaled, with the additional advantage of ability to use a greater variety of fuels.

Mr. Trump presented a translation of a paper by Professor Stumpf dealing with the subject of the uniflow locomotive with single-beat valves and exhaust ejector action.

Wm. H. Wood,[4] offered a written criticism in which he claimed that most of the devices for increasing the economy of locomotives, such as firebrick arches, feedwater heaters and superheaters, did not result in the economy claimed for them but in greater maintenance costs.

John L. Nicholson[5] called attention to the newly developed thermic siphon which had shown an average saving of 15 to 19 per cent in the fuel consumed per drawbar horsepower. If two thermic siphons were to be applied to locomotive No. 50,000, mentioned by the author, they would add approximately 62 sq. ft. to the radiant-heat-absorbing surface of the firebox, and result in an addition of 164 boiler horsepower to the capacity of the locomotive. Allowing for the net additional weight of the siphons, the result in this locomotive would be a reduction in weight per boiler horsepower from 119.6 lb. without the siphons to 113 lb. with the siphons.

W. F. Kiesel, Jr.,[6] called attention to the errors involved in using empirical formulas for steam requirements of locomotives. Thus comparison of the locomotives referred to in the first and second columns of the author's Table 1, which are the Erie No. 50,000 and the Pennsylvania K4S, respectively, show, according to the formulas, that the former is the more economical. Test results, however, are as follows:

	No. 50,000	K4S
Low rate, one test, coal, lb. per i.hp.	2.12	1.52
Low rate, one test, steam, lb. per i.hp.	16.5	14.96
Maximum i.hp.	2216	3184
Weight of locomotive in lb. per maximum i.hp.	121.4	97.0

This shows that the K4S is actually far ahead of the No. 50,000 on every count, instead of being inferior, as the comparison, based on the antiquated empirical formulas, would indicate.

Frans H. C. Coppus[7] wrote that the logical order of locomotive development, as far as combustion is concerned, should be the following:

1 Mechanical induced draft at front end
2 Condensing exhaust steam and returning condensate to tender
3 Pumping the hot water from the tender through a waste-steam and waste-gas heater into the boiler
4 Under-grate forced draft in the ashpan.

His discussion continued with an elaboration of these improvements and an estimate of the savings to be expected from their use. He looked forward, he said, to a reduction of the operating expense of a locomotive equivalent to 50 per cent of the present coal consumption. The suggested improvements, he pointed out, can be attached to all locomotives now in use and at a cost which will pay for them within a year.

John E. Muhlfeld[8] contributed a written discussion in which he developed some ideas in addition to those presented by the author, such as increased boiler pressure and superheat, compounding, reduction of the factor of adhesion, and tender boosters. He also pointed out that it would take a locomotive of considerably increased fuel economy to make worth while the scrapping of many serviceable obsolete locomotives now in use.

Carl J. Mellin[9] said that some of the formulas presented by the author should be accepted only as approximations.

Elmer A. Sperry[10] spoke of the possibilities of economy in railroad operation by the use of Diesel-engine locomotives. The possibility of using bunker oil as fuel in the new compound Diesel engine instead of the high-grade oil which the present Diesel required was going to be greatly in favor of this new type of power. It was possible, he said, that the Diesel locomotive would be combined with electric motors, to obtain the advantages of electric power and economical generation of current.

Oliver C. Cromwell[11] called attention to faulty design in providing sufficient lubrication for the locomotive trucks. He had found less packing used on the locomotive journals than on those of tender and trainler trucks.

Discussion of Paper by Walter C. Sanders

A. E. Ostrander[12] wrote that special containers for use in the transportation of high-grade freight are not new; they have been in successful operation for years. One large company in New York has purchased several lots of containers called "steel lift vans," and their method of operation is to supply one of these vans to a shipper, furnishing him with keys to special locks with which the containers are fitted. The shipper then loads his freight into the container, the lading in this case being high-grade furniture, locks it up and it is then delivered to the railroad for shipment to any part of the world.

The fact that they have continued in business, and, as indicated above, have purchased several orders of the vans, shows that it must have been profitable business for them; therefore it would certainly seem to be more profitable to a railroad to handle strictly high-grade freight in this manner.

In regard to the statement made that the use of the container car saves demurrage on freight cars, this seems unfair to the railroad if no charge is made for demurrage on the containers themselves. In other words, the shipper or the consignee has no more right to use a container as a storage warehouse than he has to hold up a car for the same purpose when he is not in a position to unload his goods.

Verbal discussion of the paper was participated in by V. N. Crocker, Supt. Mail Traffic, N.Y.C.R.R.; C. H. Otis, Asst. Supt. of Car Construction, N.Y.C.R.R.; R. H. R. Newcomb, Asst. to President, B.&M.R.R.; and F. S. Gallagher, Engr. of Rolling Stock, N.Y.C.R.R.; in which the advantages of the container car and experiences with it were brought out.

Bureau of Economic Research

This Bureau was organized for the purpose of finding and placing the facts in regard to economic questions before the public. In order to ensure the impartial and scientific treatment of the data, its Board of Directors is composed of men of widely divergent points of view.

The directors include Edwin F. Gay, President; John P. Frey, Vice-President; W. C. Mitchell, Director of Research. The Research Staff is composed of: Wesley C. Mitchell, Willford I. King, Frederick R. Macaulay, and Oswald W. Knauth.

How large is the National Income? Is it keeping pace with the growth of population? By what industries is it mainly produced? How is it distributed among our income receivers? These are the questions to which an answer is given in the report of the National Bureau of Economic Research of New York entitled "Income in the United States," which is now in press, and to be issued within a few days.

The total National Income increased very greatly between 1910 and 1919 when measured in current dollars; it increased less when calculated in unchanging dollars based on 1913 prices; the per capita income in terms of 1913 dollars increased still less.

The time-honored opinion that America is a nation of spendthrifts is brought into question by the report. The savings of individuals going into extension of plant as represented by new corporate issues of securities; public improvements financed by state and municipal bond issues; and the great number of private houses built each year; all these mount up to a large total.

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[5] President, Locomotive Firebox Co., Chicago, Ill.
[6] Mechanical Engineer, Pa.R.R., Altoona, Pa.
[7] President, Coppus Engineering and Equipment Co., Worcester, Mass.
[8] Consulting Engineer, New York, N. Y.
[9] Consulting Engineer, American Locomotive Co., Schenectady, N. Y.
[10] President, The Sperry Gyroscope Co., Brooklyn, N. Y.
[11] Mechanical Engineer, The B. & O.R.R. Co., Baltimore, Md.
[12] General Mechanical Engineer, Am. Car & Foundry Co., New York, N. Y.

Emergency Fleet Corporation Water-Tube Boilers for Wood Ships

By F. W. DEAN,[1] BOSTON, MASS.

Tests upon the standard four-pass water-tube marine boiler designed by the United States Shipping Board Emergency Fleet Corporation, using coal as fuel, were reported by the present author and Mr. H. Kreisinger in a paper read at the Annual Meeting of the Society in 1919. In consequence of the introduction of oil for fuel on many of the steamships of the United States Shipping Board, it became desirable to ascertain the relative merits on several of the available mechanical atomizing oil burners for boilers. Tests were accordingly run, the boiler used having a heating surface of 2518 sq. ft., a furnace volume of 408 cu. ft., and a commercial horsepower of 435 on the basis of the marine rating of 6 lb. of water to a square foot of heating surface per hour. These tests and the results obtained form the subject of the present paper.

OIL-FUEL EVAPORATIVE TESTS

IN THE paper presented to this Society in 1919 by the author and Mr. Henry Kreisinger, on coal-fuel tests of Emergency Fleet Corporation water-tube boilers for wood ships,[2] it was stated that oil-fuel tests were being made, and in the present paper the principal results of those tests are given.

In consequence of the introduction of oil for fuel on many of the steamships belonging to the United States Shipping Board it became desirable to ascertain the relative merits of several of the mechanical atomizing oil burners for boilers. The tests were made under the direction of the writer assisted by Mr. Henry Kreisinger, then Fuel Engineer of the Bureau of Mines, and under the critical observation of Lieut-Commander W. R. Purnell and Lieutenant Pennycook from the Philadelphia Fuel Oil Testing Plant of the U. S. Navy. As in the coal-burning tests, assistants for chemical and physical work were furnished by the Bureau of Mines, as well as by the Emergency Fleet Corporation.

The boiler tested was the four-pass boiler illustrated on p. 627 of the former paper and here reproduced as Fig. 1. In the oil tests the bottom of the casing was dropped 12 in., and the furnace on sides and bottom was lined with brickwork about 12 in. thick, there being $2\frac{1}{2}$ in. of sil-o-cel brick next to the casing. These were covered by $2\frac{1}{2}$ in. of calcined brick. The sides were still further lined with firebrick 6 in. thick and the bottom covered with two courses of standard firebrick laid flat. This formed a very effective insulation, so good, in fact, that the bricks suffered accordingly. However, it was the standard lining of the Emergency Fleet and was very satisfactory in keeping down the temperature of the fire rooms aboard ship, for which purpose it was adopted. This is shown in Fig. 2.

The furnace volume was very small, the distance between the front and back walls was only 6 ft., and the distance from the back wall to the burner tip about 6 ft. 9 in. This short distance, without doubt, prevented the atomizing capacities of the burners from being fully developed. After every series of tests the joints between the bricks opposite each burner required pointing and sometimes the bricks over a small area required replacing.

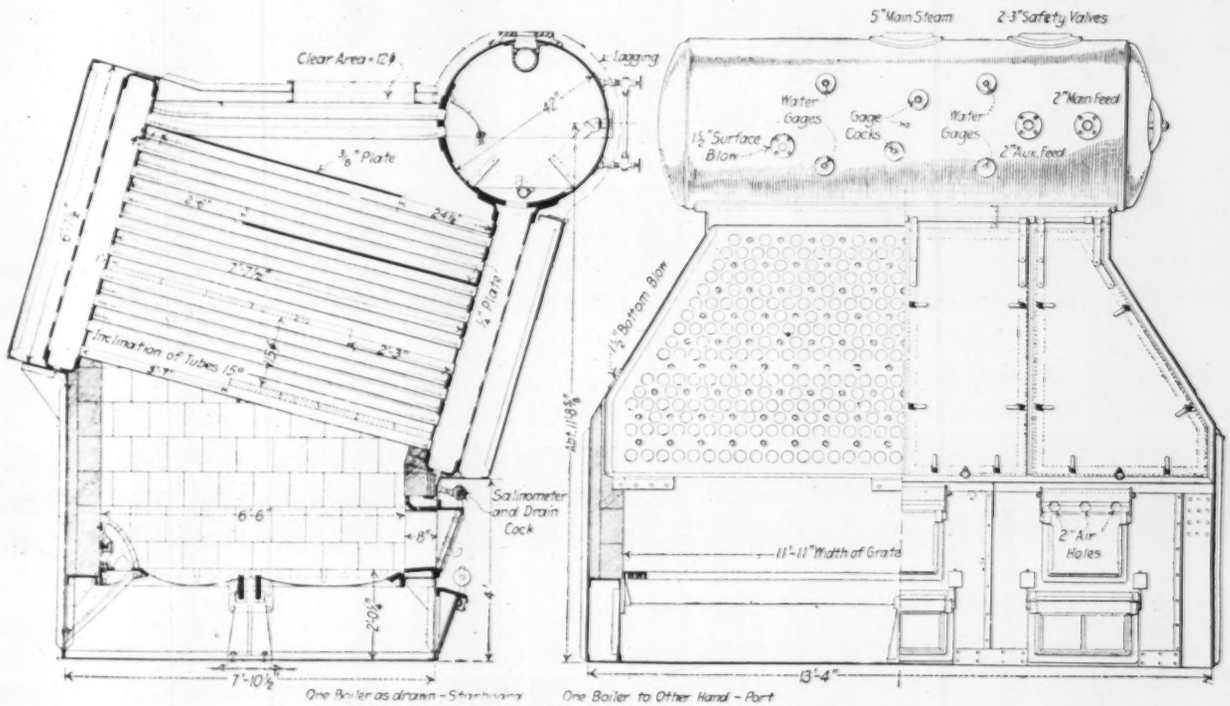

FIG. 1 FOUR-PASS STANDARD WATER-TUBE MARINE BOILER FOR WOOD SHIPS

The following were the dimensions of the firebox below the tubes

Height of furnace at front	5 ft. 0½ in.
Height of furnace at back	6 ft. 9 in.
Width of furnace	11 ft. 6½ in.
Distance between front and back walls	6 ft. 0 in.
Volume of furnace	408 cu. ft.

The boiler was equipped with thermocouples for measuring the temperatures of the gases throughout the passes and in the uptake. At the latter level there were several thermocouples for determining the temperatures at various points, for it had been previously ascertained that the temperatures in the different parts of one horizontal plane of the uptake were not uniform and varied as much as 100 deg. fahr.

Means were provided for sampling the gases at various points throughout the boiler between the vicinity of the burners and the

[1] Mfr's Agent, Wheelock, Dean & Bogue, Inc. Mem.Am.Soc.M.E.

Presented at the Annual Meeting, New York, December 5 to 9, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly abridged. All papers are subject to revision.

[2] Trans. Am.Soc.M.E., vol. 41, p. 623.

uptake. Thus the progression of the process of combustion could be ascertained. Similarly draft gages were arranged to indicate the drafts at various points.

Some of the dimensions of the boiler are given as follows:

Width of casing at floor level	13 ft. 4 in.
Length of casing at floor level	7 ft. 10½ in.
Height of center of steam drum above floor	11 ft. 8⅝ in.
Width of water spaces in headers	8 in.
Outside diameter of tubes	3 in.
Exposed length of tubes between headers	7 ft. 7½ in.
Number of tubes connecting headers	388
Number of tubes between rear header and drum	21
Steam pressure carried	210 lb.

The Oil

Mexican oil was used because it is the only oil that is usually available for steamship fuel. This oil as it comes from the wells is pressure into the weighing tank. From this tank the oil after being weighed was discharged into a tank containing a steam coil, and to this tank the pump suctions were connected. Between the pumps and suction tank the suction strainer was located and the discharge strainer was placed between the pumps and oil heater.

The Navy Bureau Standard Burner

This burner is shown in Fig. 3, and consists of a circular cast-iron register with inclined (not radial) blades around the outside between two thin narrow rings with which they are cast, so formed that the air passes between them somewhat toward the center of the burner, and by them is given rotation.

The register is suitably bolted to the boiler front, but between it and the front there is a conical ring which serves to direct the air toward the oil and counteract the opposite tendency caused by the centrifugal effect of the register.

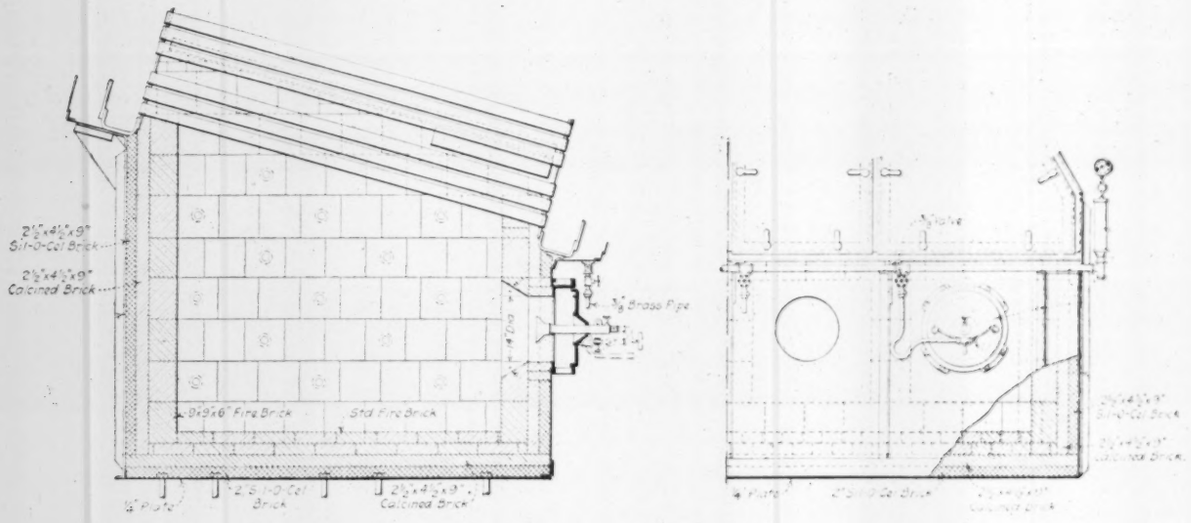

Fig. 2 Arrangement of Furnace of Boiler for Oil Firing

of about 21 gravity Baumé. About 12 per cent to 13 per cent of gasoline is removed, leaving the oil at about 16 gravity Baumé. The heating value per pound is about 18,330 B.t.u.

The first sample taken was found by the Bureau of Mines to have the following properties:

Specific gravity at 15 deg. cent	0.960
Gravity, Baumé, modulus 140, at 60 deg. fahr	15.8
Viscosity, Engler, at 65.5 deg. cent	19.21
Calories per gram	10,179
British thermal units per pound	18,323
Water, per cent	0.00
Sulphur, per cent	3.88
Mineral matter, sand, etc., per cent	0.00
Flash point (Pensky-Martens closed tester)	72 deg. cent.
Burning point (Pensky-Martens tester opened)	116 deg. cent.
Solid at	−2 deg. cent.

Other samples, of which many were taken, differed but slightly from this.

The Burners

As stated before, all burners tested were mechanical atomizing. This type is used at sea in order that all steam used in heating the oil may be condensed and saved for feedwater.

Six kinds of burners were used, No. 1 being the U. S. Navy Bureau (of Steam Engineering) Standard Register Burner.

Other Apparatus

The oil was supplied to the burners by either of two horizontal duplex pumps, 5¼ in. by 3½ in. by 5 in. A pair of suction and a pair of discharge oil strainers and an oil heater were loaned by the Schutte and Koerting Company. On the discharge pipe of the oil pumps there was a 6-in. air chamber about eight feet high, which maintained the oil pressure at the burners sufficiently steady for the best results. This chamber was emptied of oil at the beginning of each test and charged with air at 100 lb. pressure.

The oil was heated in the railroad-car tank and forced by air

The oil is forced through a pipe to the so-called tip, which is screwed on the pipe and serves the purpose of delivering the oil to the furnace in a rapidly rotating stream passing through a very small hole. The tip consists of two hardened steel parts, the outer one being called the "nut," and apparent on the drawing. The nut has a conical cavity with the apex toward the furnace and the

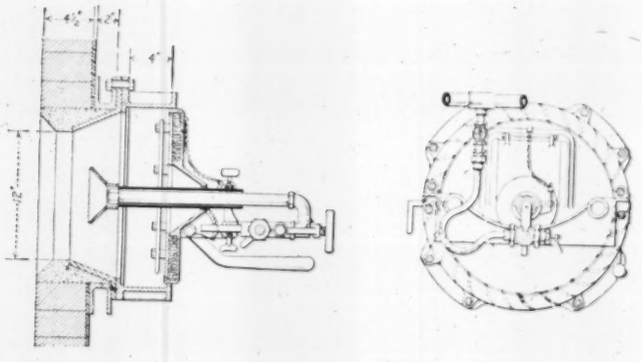

Fig. 3 The Navy Bureau Standard Burner

other part is conical and fits it in firm contact. The latter is provided with tangential grooves fed by small holes and these grooves serve to rotate the oil as above mentioned.

The centrifugal force derived from the rotation of the oil causes the latter to spread into the form of a thin hollow cone, which is protected from the inrushing air from the register by a cast-iron cone until it reaches an advisable thinness at the edge of the cone, where it is met by the rotating air with which it is thoroughly mixed. Immediately beyond this line of mixture the ignition occurs and the completeness of combustion depends upon the ade-

quacy of the quantity of air, the completeness of the atomization of the oil, and the thoroughness of the mixing.

The other burners have tips that rotate the oil, as this is indispensable in thinning the oil film, but burner No. 4 rotates the air but little, and No. 6 not at all. This demonstrates that the rotation of the air is not necessary, a conclusion that might otherwise have been reached.

THE TESTS

Four burners of each kind were applied to the boiler, and, except the Navy Bureau Standard burner, were placed with their centers 30 in. apart and 20 in. above the furnace floor, leaving 24 in. between the side walls of the furnace and centers of the adjacent burners. In some of the tests the Bureau burners were arranged likewise, but at the beginning they were placed with their centers 36 in. apart and 22 in. above the furnace floor, leaving 15 in. between the side-burner centers and the walls. No advantage in either spacing could be discerned.

The first burner to be used was the Bureau, and on account of inexperience with Mexican oil very poor results were for some

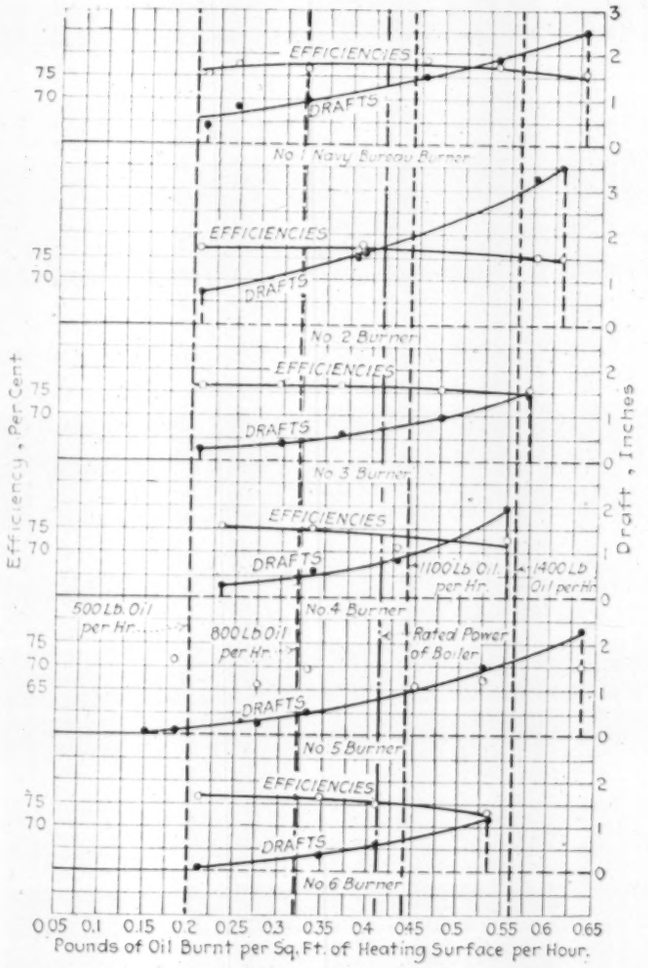

FIG. 4 EFFICIENCIES AND DRAFTS OF SELECTED TESTS

time obtained and immense amounts of smoke made. With more experience excellent results were obtained and there was no difficulty in preventing smoke with this or any burner. In general a slight amount of smoke was allowed.

At the beginning there was frequent difficulty from the carbonizing of the oil, but this was gradually overcome.

The criteria by which the merits of a burner can be judged when used with induced draft are its ability to burn the oil to CO_2, to do this with a minimum of draft, to produce little smoke, to produce no carbonization in the burner, and to have sufficient range in oil-burning capacity.

To produce desirable CO_2 the oil atomization must be well performed and the air admitted in such a manner that it will intimately mix with the oil.

A common feature of all the mechanical atomizers tested is the rapid rotation of the oil as it enters the furnace, as in the Bureau burner. This is produced, as in that case, by forcing it at high pressure through small channels of various forms tangential to a small central hole in the burner tip through which it passes to the furnace. As it issues it rotates rapidly and the centrifugal force expands it and forms a thin conical shell of oil. While expanding it is usually protected from the incoming air by a thin cast-iron conical shell of advisable diameter placed in front of it with its base toward the

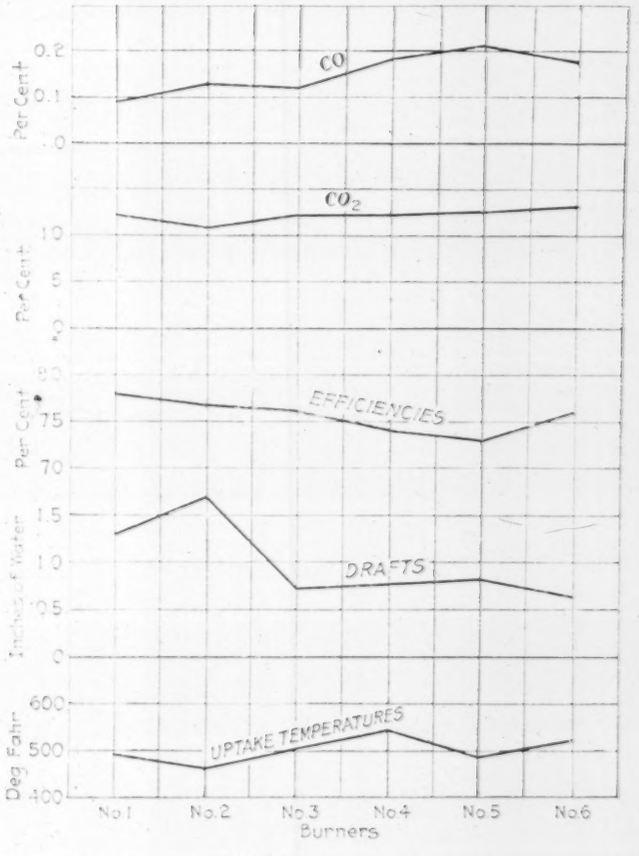

FIG. 5 COMPARISON OF BOILER EFFICIENCIES, DRAFTS, CO_2 AND UPTAKE TEMPERATURES AT RATED POWER OF BOILER WITH DIFFERENT BURNERS, AND AVERAGE CO OF SELECTED TESTS

furnace. When the oil reaches the edge of the cone it is swept by the incoming air and the mixing and ignition occur.

RESULTS OF THE TESTS

The results of the tests which are considered to be most reliable and to represent the merits of the burners are given in four tables in the complete paper, of which Table 1 is representative. With each burner several preliminary tests were made before sufficient skill was acquired to obtain consistent results, and these are omitted. It may be well to remark here that the representatives of the burners were not able to operate them successfully, which indicates that the efficiencies of boilers with oil fuel are very uncertain.

It was intended with each kind of burner to consume oil at four different hourly rates for four burners collectively, namely, 500 lb., 800 lb., 1100 lb., and 1400 lb., but it was impossible to realize these results with precision.

In judging the merits of a burner by the magnitudes of the CO_2 and CO, a difficulty is encountered from the fact that these constituents are not uniformly distributed throughout the area in which they are determined, whether it is in the uptake or in one of the passes.

Usually, in the boiler tested, the combustion is complete by the time the gases reach the first or lowest pass of the boiler, but if the gases are sampled in this pass they are far from uniform at different

points between the end of the baffle and rear header. The following are examples:

Test No.	CO_2 5 in. from header per cent	CO_2 17 in. from header per cent	CO_2 39 in. from header per cent
41	10.6	10.4	11.1
42	11.9	14.2	14.3
43	10.0	12.3	12.6
44	11.9	13.3	13.6
45	11.6	—	13.6
46	12.6	12.8	12.9

While the above are at different distances from the end of the baffle, the following are at the same distance and at different points in a line parallel to the end of the baffle and 19 in. therefrom:

Test No.	Position C CO_2 per cent	Position D CO_2 per cent	Position E CO_2 per cent
26	11	12	12.3
36	12.9	9.5	11.8

Similarly the other ingredients of the gases vary.

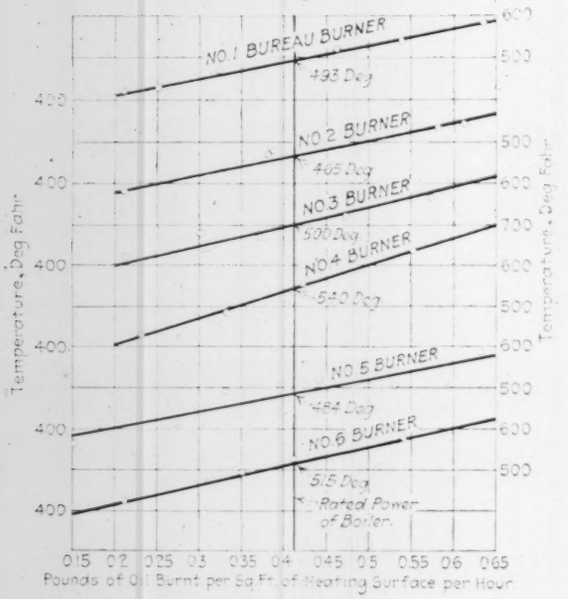

FIG. 6 TEMPERATURE GRADIENTS FOR DIFFERENT RATES OF OIL CONSUMPTION WITH DIFFERENT BURNERS

This variation of the gases of combustion renders it difficult to apply the chemical criterion in determining merits of a burner. In operating burners, of course, constant studies of the gas analyses are made, and this is necessary, for if the CO_2 is good at one point it is probable that it is at others. Nevertheless, it is necessary to determine the efficiency of the boiler under the same conditions as a final means of judging of the performance of a burner. It may be found that the maximum boiler efficiency will not correspond with the maximum CO_2, and this is true with these tests.

In the tables of results given the following efficiencies and average CO_2 and CO occur, and are here listed in the order of the burner trials.

Burner	Average efficiencies, per cent	Average CO_2 per cent	Average CO per cent
No. 1	77.02	11.88	0.09
No. 3	75.94	12.16	1.12
No. 4	73.50	12.00	1.18
No. 6	75.10	12.71	0.18

In Fig. 4 the efficiencies and drafts of the various burners are plotted. The Bureau Standard burner required more draft than the others. The reason for this is that it was designed for use on war vessels and made to require a strong draft, or fire-room pressure, in order not to backfire from gun shock.

In Fig. 5 a diagram of comparative uptake temperatures, drafts, efficiencies, CO_2 and CO is given.

In Fig. 6 the uptake temperature gradients of the different burners are shown. It will be noticed that the burner of lowest efficiency gave the steepest gradient. In Figs. 4, 5, and 6 all burners are included.

Burner No. 6 required the least draft and the least adjusting. It was the only burner that did not vibrate; it gave the highest CO_2, but also next to the highest CO. All other burners required constant adjusting to maintain proper CO_2, and the reason for this could not be ascertained.

TABLE 1 RESULTS OF EVAPORATIVE TESTS OF FOUR-PASS BOILER EQUIPPED WITH FOUR NO. 1 OIL BURNERS

Fuel Oil Used: Mexican Petroleum Residuum

1	Test number	37	33	29	38	31	36
2	Date of trial, 1919	Aug. 8	Aug. 1	Jul. 26	Aug 9	Jul. 30	Aug. 7
3	Duration of trial, hr	7¼	6	8	4 88	7	5
4	Barometer, in.	29.4	29.3	29.5		29.5	29.14
5	Number of burners used	4	4	4	4	4	4
	DIMENSIONS AND PROPORTIONS						
6	Furnace volume, cu. ft.	408	408	408	408	408	408
7	Heating surface, sq. ft.	2518	2518	2518	2518	2518	2518
8	Ratio of h.s. to f.v.	6.13	6.13	6.13	6.13	6.13	6.13
	AVERAGE PRESSURES						
9	Steam pressure by gage, lb.	200.2	197.0	203.1	196.7	193.60	201.0
10	Atmospheric pressure, lb.	14.46	14.26	14.51		14.51	14.34
11	Absolute pressure, lb.	214.66	211.26	217.61		208.11	215.34
12	Draft between damper and boiler, in.	0.382	0.774	0.947	1.475	1.902	2.51
	AVERAGE TEMPERATURES						
13	External air, deg. fahr.	72.8	74.6	82.8	70.6	74.6	86.2
14	Fire room, deg. fahr.	74.7	83.6	89.8	79.2	84.9	92.7
15	Feedwater, deg. fahr.	116	90	68.6	85.9	73.7	91.7
16	Escaping gas, deg. fahr.	414	412	465	516	538	583
17	Furnace by optical pyrometer, deg. fahr.	2198	2230	2331		2551	2654
	FUEL DATA						
18	Oil consumed per hour, lb.	527	615.5	807.8	1137.8	1341.0	1584.6
19	Oil per hour per sq. ft. heating surf., lb.	0.211	0.246	0.325	0.455	0.537	0.634
20	Oil per hour per cu. ft. of fur. vol., lb.	1.292	1.509	1.98	2.79	3.29	3.882
21	Oil per hour per burner, lb.	131.8	153.9	201.95	284	335.3	396.2
22	Temperature of oil at burners, deg. fahr.	266	264.1	276.5	283.4	260	281
23	Pressure of oil at burners, lb.	146.2	181.9	249.3	167.8	228	236.4
24	Heat value per pound of oil, B.t.u.	18376	18376	18352	18376	18376	18376
25	Moisture in oil, per cent	0.15	0.15	0.05	0.15	0.15	0.15
26	Silt, per cent	0.00	0.00	0.00	0.00	0.00	0.00
27	Specific gravity at 60 deg. fahr.	0.962	0.962	0.96	15° C., 0.962	0.962	0.962
28	Viscosity, deg. Engler at 65.5 deg. cent.	20.39	20.39		20.39		20.39
29	Flash temperature, deg. fahr.	167	167	158	167	167	167
30	Burning temperature, deg. fahr.	270	270	266	270	270	270
31	Carbon, per cent	84.02	84.02	84.19	84.02	84.02	84.02
32	Hydrogen, per cent	11.00	11.00	11.11	11.00	11.00	11.00
33	Sulphur, per cent	4.04	4.04	4.07	4.04	4.04	4.04
34	Gravity at 60 deg. fahr., Baumé scale	15.50	15.50	15.80	15.53	15.54	15.54
	QUALITY OF STEAM						
35	Moisture in steam, per cent	1.11	1.04	0.91	6.85	0.87	0.93
	EFFICIENCY						
36	Efficiency of boiler and furnace, per cent	75.9	77.7	76.8	78.9	77.0	76.1
	WATER AND EVAPORATION						
37	Water supplied to boiler per hour, lb.	6663	7783	9876	14520	16555	19620
38	Dry steam generated per hour, lb.	6590	7700	9790	14397	16400	19437
39	Factor of evaporation	1.150	1.176	1.198	1.180	1.192	1.174
40	Evap. per hour from and at 212° fahr., lb.	7580	9060	11730	16988	19550	22819
41	Do. per sq. ft. heating surface, lb.	3.03	3.62	4.69	6.80	7.82	9.14
42	Actual evaporation per lb. of oil, lb.	12.50	12.51	12.12	12.65	12.22	12.27
43	Equivalent from and at 212° fahr., lb.	14.38	14.72	14.53	14.93	14.57	14.40
44	Do. per cu. ft. of furnace volume, lb.	18.57	22.20	24.00	41.63	47.93	55.95
	POWER OF BOILER						
45	Land hp. obtained (rated at 250 hp.)	220	263	340	492	567	661
46	Per cent of land rating obtained	88	104	136	197	227	265
47	Equiv. land hp. of marine rating	435	435	435	435	435	435
48	Per cent of marine rating obtained	51	60	78	113	130	152

DISCUSSION

IN the discussion which followed Mr. Dean's paper, Past-President D. S. Jacobus presiding, Joseph Nelis, Jr.,[1] who had been associated with the author in the early part of the tests, said, in reply to questions, that an attempt was made with the standard size adopted to run up to as high a capacity as possible—higher than they would be on shipboard—and that in some of the higher ratings the brickwork melted. The burners employed were all mechanical

(*Continued on page 104*)

[1] Manager, Marine Dept., Power Specialty Co., New York, N. Y. Mem. Am.Soc.M.E.

Motion Pictures of a Stoker Furnace in Operation

By R. SANFORD RILEY,[1] WORCESTER, MASS.

THE moving-picture method of showing furnace operation is the result of about ten years of study and experiment in an effort to show continuously the action of a fuel bed. The opportunity thus offered of studying the fuel bed in operation may suggest new lines of investigation and development. The first intimate contact with a roaring-hot stoker fire usually developed the fact that motion-picture cameras were valuable and must be treated with more respect. A temperature approaching 3000 deg. fahr. presented new problems even to the most versatile motion-picture expert.

These difficulties in the observation of the phenomenon of the combustion of coal were finally overcome by the ingenuity and persistence of F. H. Daniels[2] so it is to him we owe the invention and accomplishment here described.

The camera (Fig. 1) was mounted at the right height on a stand which was arranged to roll up to the door. A heavy asbestos shield was built to protect the front and side of the camera. The shield over the front was made to fit more or less accurately in place of the door, while the shield at the side was made to protect the camera against the hot brick lining of the door when the latter swung open. This arrangement made it convenient to run the camera up into position as soon as the door was opened and maintain the furnace conditions the same as when the door was shut. Fig. 1 shows the operator in position with the door opening closed by

FIG. 1 ARRANGEMENT OF CAMERA BEFORE FURNACE DOOR

the front shield and the hot door lining covered by the side shield shown. Even with these precautions, an electric fan was required to keep the camera safe and the operator less uncomfortable.

Of course, the real problem was the protection of the camera lens during the time it had to be exposed. The hole allowing the camera lens to look through the front screen was normally closed by another asbestos plate. This plate was tripped open by the operator's foot only during the time pictures were to be taken. Note the pedal and pulley connections thereto in Fig. 1.

For protection of the camera lens, a water cell with glass windows was first tried. A forced circulation of water through the cell did not prevent the glass from cracking. This defect was remedied by using special Pyrex glass, but it was found that air bubbles were formed on the side next the fire and even distilled water did not prevent them. These of course spoiled the clearness of the pictures. Finally, the combination of two sheets of heat-resisting glass with a thin sheet of gold between was tried. The gold acted as a mirror and threw back into the furnace approximately 75 per cent of the radiant heat, while it allowed approximately 75 per cent of the light rays to pass through. This protector for the lens was itself protected by two jets of compressed air arranged to impinge and mushroom in front of the opening in the asbestos screen. (See the hose connection in Fig. 1.) This air had to be delivered at

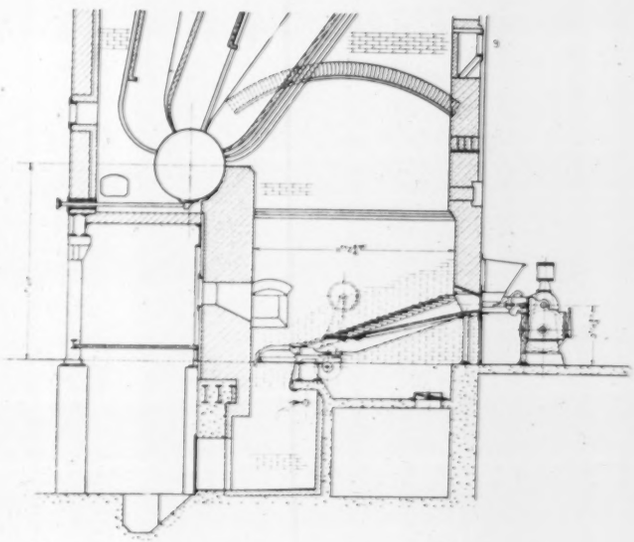

FIG. 2 CROSS-SECTION OF FURNACE SETTING

approximately 100 lb. pressure in order to get the required cooling effect. Furthermore, it had to be clean and free from all moisture and oil. The trap shown underneath the camera was drained frequently in order to insure clean air.

In addition to the screening effect of the gold leaf, it was found necessary to use what is called a Wrattan filter in order to prevent halations on the film.

At the suggestion of John A. Stevens, Mem.Am.Soc.M.E., a spectrometer was used in the fire and this showed a complete spectrum from reds down to violet and a brilliant yellow sodium line. The blues and purples increase in intensity, depending on the temperature of the fire viewed through the spectrometer. A panchromatic film stock was used to bring out the reds of the spectrum. This combination of gold screen, Wrattan filter and panchromatic film shows the texture of the fire well enough for the purpose.

The pictures were taken at the plant of Bird & Son, Inc., East Walpole, Mass. The boiler is a Stirling, of 822 hp., equipped with a 9-retort extra long Riley underfeed stoker. This installation was made by John A. Stevens, Engineer, of Lowell, Mass. and a cross-section of the furnace setting is shown in Fig. 2. The height of the mud drum being 11 ft. above the floor line allowed the use of the rear door shown in addition to the usual side observation door. Both these doors were used for taking pictures and proved just as convenient for this as they are for observation in everyday use.

Fig. 3 is a typical view through the rear door and Fig. 4 through the side door. Restriction of the view due to limited flare of the brickwork around the doors is a handicap but does not interfere with a study of the limited area seen. It is hoped later to get more extended views through specially flared door openings, but in this

[1] President, Sanford Riley Stoker Co. Inc. Mem.Am.Soc.M.E.

[2] General Manager, Sanford Riley Stoker Co., Inc., Asso-Mem.Am.Soc. M.E.

Remarks accompanying presentation of motion pictures, under auspices of the Fuel Division, December 8, 1921, at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

case it was necessary to take pictures under usual service conditions. It is also planned to make special studies of side-wall clinker action, and development of clinkers elsewhere in the furnace. The operating conditions were normal during the week these pictures were taken. It took nearly an entire week to get satisfactory motion pictures of the fire alone, and altogether about 2000 ft. of film were used up in order to get the 700 ft. shown. There was no attempt made to have the fire in any special condition. The pictures were taken generally as the apparatus could be prepared for action, and some of the operation shown is better as an example of what not to do.

The pictures taken and reproduced at normal camera speed show nothing much more interesting than the still pictures reproduced in Figs. 3 and 4, except perhaps the pictures of the banked fire and

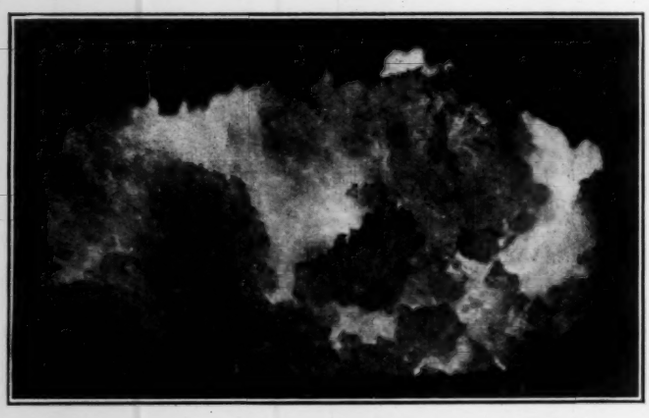

Fig. 3 Typical View through Rear Door of Furnace

Fig. 4 Typical View through Side Door of Furnace

the dumping. The change from banked fire to 300 per cent of rating in six minutes is less monotonous than normal operation and shows quite clearly what happens in breaking up a fire bed that has been standing overnight. The dumping shows what happens if stokers of this type are dumped with a heavy fuel bed.

The most interesting features, and certainly the most dramatic, are those taken at intervals and speeded up like the well-known pictures of a growing plant, though of course no such great magnification of speed was used. Some of the pictures were taken at intervals of six and eight seconds. These show some appreciable change in the fire and when speeded up to normal reproduction rate of sixteen per second, there is an action worth watching. Particular attention will be called to some of these highly speeded-up pictures where the fuel bed appears to be "shimmying" on its way instead of "inching" along at a scarcely perceptible rate. The disintegration and melting away of the fuel is clearly shown as is also the gradual segregation of the non-combustible matter in the form of clinkers on the surface. It is to be regretted that there appears to be no way of getting a cross-section of the fire, although we hope to find a way of making some additional observations below the surface.

DISCUSSION ON E. F. C. WATER-TUBE BOILERS FOR WOOD SHIPS

(*Continued from page 102*)

atomizing burners, as steam atomizers wasted too much make-up water. Up to the ratings possible in marine work—4.5 to 6 lb. of evaporation per square foot of heating surface—smokeless operation was possible with oil at the proper temperature and pressure.

John A. Stevens[2] gave interesting particulars of the oil-burning installation on the Cunard liner *Mauretania*, describing the periscopes on the uptakes for observing the character of smoke passing, the foamite tanks for use in extinguishing oil fires, etc. The furnaces on the *Mauretania* were somewhat small—46 in. in diameter—and the combustion chamber restricted. The installation made it possible to dispense with 450 firemen and coal trimmers.

F. W. Leahy[3] called attention to the electric-drive vessels of the U. S. Shipping Board, which were provided with oil-burning Scotch boilers and all of the improvements that had been mentioned in connection with the *Mauretania*.

N. E. Lewis[4] gave particulars regarding the dimensions of a 450-hp. water-tube boiler with 4-in. tubes 14 ft. long and equipped for oil burning, as well as of a 2-in.-tube marine-type boiler. The efficiencies reported were perceptibly higher than those given in the paper. Mr. Lewis said that he had noted a statement in the paper that the efficiencies of boilers with oil fuel are very uncertain. He believed that a well-designed mechanical oil burner would give higher efficiencies with less care and manipulation on the part of the operator than any other fuel-burning apparatus. The adjustment of air and oil pressures was practically all that one had to watch, other than seeing that the burners were kept free, and it was not like the coal-fired, gas-fired, or other kind of boiler where several other elements entered into the operation.

Superpower

There are few who understand the superpower plan in detail, but the public does not understand it in general.

Even men in the business regard it as a collection of extra-large power houses and say that the superpower station of yesterday is the ordinary plant of today.

Perhaps they make a difference between the superpower station and the superpower plan, although they mingle them in writing and in conversation.

Look over an industrial city block of a few years ago. There are in it a dozen or twenty separate power plants. On the back street several small industries, each with its boiler and engine, coal carts from different dealers backing up and leaving the fuel, a ton or two at a time. Oil, packing and supplies bought in driblets. No one of them big enough to support a real engineer. On the main street some office buildings with more pretentious and efficient power plants, but the aggregate employing many more men than were needed, burning more fuel and paying more for their supplies than would be necessary in a well-designed and operated plant that could furnish not only power, but light, heat, hot and cold water, compressed air, vacuum, refrigeration, etc., to the entire block.

Extend this idealization to a section of the country instead of to a city block, and you have a conception of the superpower plan.

Only the superpower plan does not contemplate merely building a single immense power station for each industrial block or district and tying them all together. It proposes an intelligent engineering study of the power needs and the available sources of power supply for a district and a combination and coördination that will give to each subdivision of the district a dependable supply of power in the cheapest and most economical way.

It is the organization, the systemizing, the rationalizing of the power resources of the country.

And it is time that somebody began to think of power in that way; to look ahead to the time when the world will have to decide the purposes for which fuel may be burned and power used; to pick the essential industries. This time is already in sight so far as liquid fuels are concerned.—F. R. Low, Mem.Am.Soc.M.E., in *Power*, Jan. 10, 1922.

[2] Consulting Engineer, Lowell, Mass. Mem.Am.Soc.M.E.

[3] Marine Manager, Diamond Power Specialty Co., New York, N. Y. Mem.Am.Soc.M.E.

[4] Babcock & Wilcox Co., New York, N. Y. Mem.Am.Soc.M.E.

A Study of the Elastic Properties of Small-Size Wire Cable

By R. R. MOORE,[1] DAYTON, OHIO

In aircraft work use is made of several varieties of small-diameter steel cable, knowledge of the physical characteristics of which is important for efficient design. The present paper gives results of a series of tests carried out at McCook Field, Dayton, Ohio, in which it is shown that the modulus of elasticity of small-sized wire aircraft cable varies from 15,000,000 to 28,000,000, depending upon the size and type of the cable. The maximum difference between moduli of specimens of the same size and type of cable may be as high as 3,000,000.

It was also found that the modulus of elasticity may be raised by loading the cable below the elastic limit, and that resting the cable does not seem to have any definite effect on the modulus. The elastic limit may be raised by loading the cable a little beyond this point, the maximum increase obtained amounting to 63 per cent of the original elastic limit.

THE development of aircraft has brought into use several varieties of small-diameter steel cable, a knowledge of the physical characteristics of which is important for efficient design. Such information becomes vitally important to engineers who are concerned with the development of new types of aircraft and the advancement of the science of aviation in general. This is the case at the Engineering Division of the Air Service, located at McCook Field, Dayton, Ohio. The subject was first brought to the attention of the Material Section by a request from the Design Section for stress-strain curves on various sizes of the 19-wire non-flexible type of aircraft cable. After completing these tests the investigation was extended to cover all the available types of cable used in airplane construction.

Engineering handbooks do not quote any value for the elastic limit of wire cable, and for the modulus of elasticity they give a value of about 12,000,000. This value, however, refers to wire ropes with hemp centers and for sizes greater than $^3/_8$ in. In aircraft work we are mostly concerned with ropes made of high-strength steel wire in sizes less than $^3/_8$ in. and types which have either a wire or wire-strand center. The value for the modulus of this type of cable is considerably greater than 12,000,000.

While the determination of ultimate strength is a comparatively simple matter, the accurate measurement of elongation necessary in determining the elastic limit and modulus of elasticity presents several difficulties. In the first place, the fact that the cable is built up of so many small wires and strands makes it difficult to locate accurately a definite gage point and attach an instrument there without its shifting in position. It is evident that the usual type of extensometer with pointed screws for grips is of no use for this work. In the second place, a cable twists when under load, so that any rigid instrument cannot be used.

Tests were made on a 20,000-lb. Olsen structural-material and airplane-parts testing machine which was previously calibrated and found to be in good adjustment. However, in several cases the measurement of load was obtained from the deflection of an accurately calibrated spring placed on the upper head of the machine and arranged so as to take the load applied to the cable. The deflection of the spring was measured with an Ames dial reading to 0.001 in. It was found that this method gave more consistent results because it was considerably more sensitive to small variations in load than the lever system of the testing machine. In fact, some such arrangement is absolutely necessary in testing the small cables, particularly the $^1/_{32}$, $^1/_{16}$, and $^3/_{32}$-in. sizes, in order to obtain the elastic limit and modulus with any degree of accuracy. To obtain the breaking load, however, the spring must be removed and the load measured on the machine. A view of the complete set-up with extensometer attached is shown in Fig. 1.

The instrument used was very similar to the familar wire-wound dial type of extensometer. The greatest difficulty was in attaching the dial to the cable at the gage point. This was accomplished by attaching the dial to a specially devised clamp as shown in Fig. 2. At the other gage point, a second clamp was attached similar to the one holding the dial. To this clamp one end of a fine magnet wire was attached; the wire extended down the cable and around the brass drum, the loose end having a light weight attached to it. It is clear, then, that as the two gage points moved apart the wire turned the drum and shaft upon which the needle was mounted, thus recording directly on the dial the elongation of the cable.

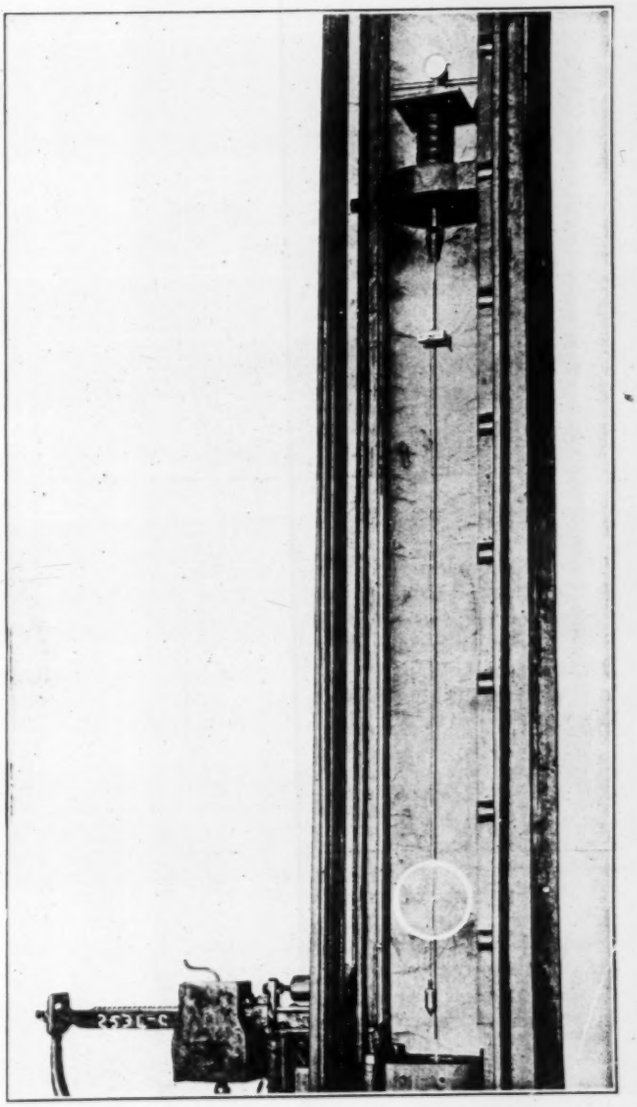

FIG. 1 COMPLETE SET-UP OF APPARATUS WITH EXTENSOMETER ATTACHED

In order to reduce the error occurring from this twisting, the wire was placed as near the cable as possible and hardly exceeded $^1/_2$ in. from the center of the cable at any time. As the maximum twist noted did not exceed 90 deg., the error incurred in the modulus due to this error of elongation is negligible.

Cables of four different types of construction and one made of phosphor-bronze wire were tested, the types and sizes tested being given in Table 1.

A chemical analysis of several wires taken from the phosphor-bronze cable gave the following composition: tin, 3.77; copper,

[1] Chief, Physical Testing Branch, Material Section, McCook Field.

Abstract of paper presented at the Annual Meeting, New York, December, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

95.60; zinc, 0.34; phosphorus, 0.28. A chemical analysis of several wires from the steel cables gave the following composition: carbon, 0.64; manganese, 0.55; phosphorus, 0.033; sulphur, 0.033.

In Fig. 3 is shown the arrangement of the wires and strands in the four different types of cables.

Stress-strain curves for computing the modulus and locating the elastic limit were plotted on cross-section paper with a scale of 1 in. equal to 0.01 in. actual elongation in 50 in. The vertical scale was made so as to give the curve a slope of about 45 deg. with the horizontal. This large-scale plotting showed the readings of the extensometer to be very consistent, indicating that the cable was stretching uniformly and also twisting uniformly.

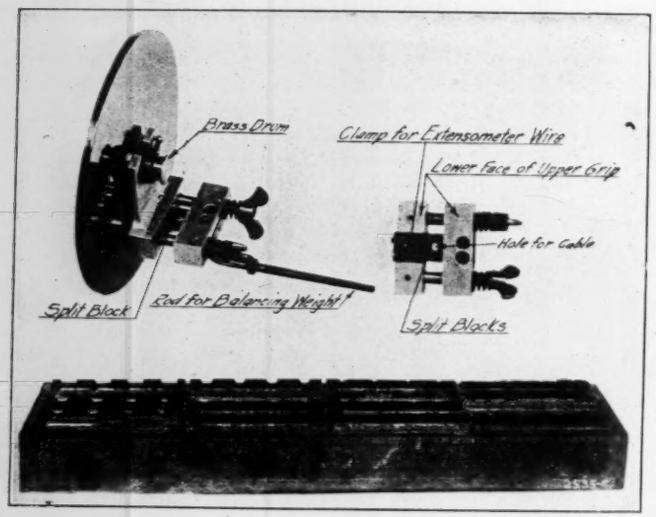

FIG. 2 EXTENSOMETER CLAMP

The values for elastic limit were obtained by selecting the highest point on the straight-line section of the stress-strain curves. Strictly speaking, this is not the elastic limit but the proportional limit. (American Society for Testing Materials.)

However, as the majority of practical designing engineers use the term "elastic limit" to designate what is actually the proportional limit, we have also used it in that sense in order to avoid confusion.

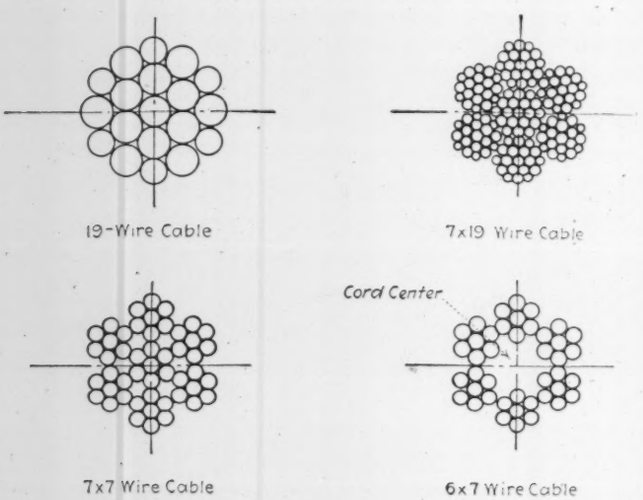

FIG. 3 TYPES OF CABLE CONSTRUCTION

There is considerable variation between the modulus of different-sized specimens of the same type. In order to show the comparative modulus values for the different types of cable, Table 2 was prepared, selecting the same size of cable from each type as nearly as it was possible to obtain.

There is in several cases quite a difference between the first-run modulus obtained on different specimens of the same cable. The largest of these differences is in these 1/8-in. 7 by 19 cable, specimens 13 and 14, which show a difference of about 3,200,000; and the 6 by 7 cable, specimens 16 and 40, which show a difference of 2,760,000.

The highest modulus obtained on any cable is 27,793,100. This value was obtained after loading below the elastic limit. It should be remarked here that this value is more than twice as large as the value 12,000,000 which is commonly quoted for wire rope.

The largest increase in modulus is found in the 1/8-in. 7 by 19 cable, which shows an increase of 6,600,000 after loading above the yield point. It is noticeable that this maximum increase occurs on the smallest-sized cable. The phosphor-bronze cable shows the

TABLE 1 TYPES AND SIZES OF CABLES TESTED

Type	Material of Wires	Protective Coating on Wires	Diameter of Cable
19 wire	Steel	Tinned	1/32*, 1/16, 7/64, 1/8, 5/32, 7/32
7 by 7	Steel	Zinc-plated	1/16, 3/32, 5/32
7 by 7	Steel	Tinned	7/32
6 by 7	Steel	Zinc-plated	9/64
7 by 19	Steel	Tinned	1/8, 5/32, 7/32, 9/32, 11/32
7 by 19	Phosphor-bronze	None	7/32

* This cable has only 7 wires because of its small size.

TABLE 2 COMPARATIVE MODULUS VALUES FOR DIFFERENT TYPES OF CABLE

Type	Size	Average 1st Run Modulus	Average Modulus after Loading above Yield Point
19 wire	5/32	24,870,000	25,687,000
7 by 7	5/32	19,505,000	22,985,000
6 by 7	9/64	17,989,000	20,660,000
7 by 19	5/32	15,605,000	20,112,000
7 by 19[1]	7/32	11,307,000	11,953,000

[1] Phosphor-bronze.

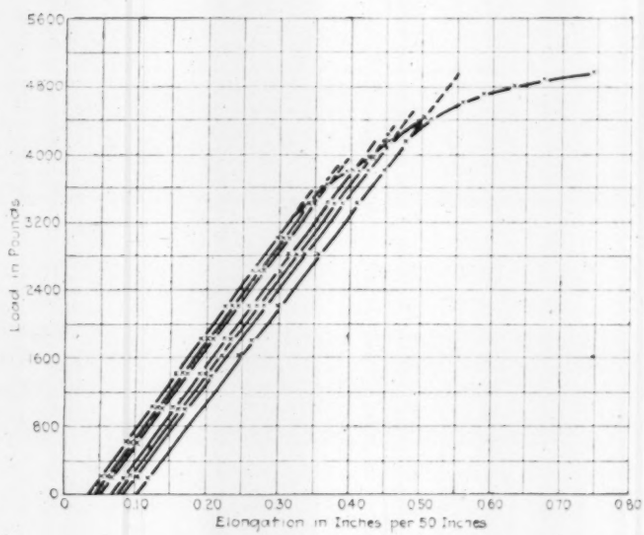

FIG. 4 RISE IN ELASTIC LIMIT OF 3/16-IN. 19-WIRE NON-FLEXIBLE STEEL-WIRE CABLE

smallest increase in modulus of any of the other cables, even though it is of the same type of construction (7 by 19) as the one which showed the greatest increase.

While it is true that the modulus is raised a greater amount by loading above the yield point than below the elastic limit, it is to be remembered that a very large part of this increase is due to the loading below the elastic limit. It is evident, then, that the net effect of loading above the yield point is small.

The final object of this investigation was to determine whether it is possible to raise the elastic limit by loading a little beyond this point. The results of one set of runs made to show this are given in Fig. 4. These curves indicate definitely that the elastic limit can be considerably increased.

The amount of increase obtained on the cables tested is as given in Table 3, page 111.

(Continued on page 111)

Air Lines and Some of Their Problems

By R. B. C. NOORDUYN,[1] NEW YORK, N. Y.

To those who are interested in the early and successful development of commercial air lines in this country, this paper will give an index of the problems to be solved, both from the point of view of development of the machine itself, as well as of such important accessory factors as proper landing facilities, ground organizations, legislation, and insurance.

The author gives a detailed account of the progress of commercial aviation in Europe, tracing the development from the time of the post-war experimental work with military machines and fields, to the present successful operation with proper machines and schedules and with Government subsidies.

His ideas are authoritative, and hence valuable, and his presentation of the problems of air lines should do much toward helping to secure the establishment of air travel in this country as a factor of every-day life.

THE air lines in operation in Europe since 1919 have proved a great attraction for Americans who have formed, in fact, a surprisingly large percentage of the passengers carried. The favorable impression which they invariably bring home of the new method of travel encourages the belief that once air lines are running in this country and can promise to equal the performance of those with which the traveler has become familiar abroad, public support will be forthcoming to a greater degree than has been generally anticipated.

In the United States last year, the mileage covered by commercial or privately owned airplanes was estimated by the Manufacturers' Aircraft Association, from reports received from operators all over the country, to be not less than six million miles, in the course of which some 225,000 passengers were carried. The Frenchman, who is accustomed to using a time-table for the next plane for London or Amsterdam, and buying his ticket at the nearest travel bureau looks at these figures and thinks that the air lines in this country must be doing a good business. If this large mileage were actually covered in the operation of scheduled services over fixed routes, instead of in unorganized short flights, we could indeed consider air-travel to be an established factor in every-day life.

As a precursor of regular services the present volume of flying must not be underrated. Its educative value is very great as the passengers carried on short flights now will be the patrons of the air lines of the future. Further, personnel, pilots, and mechanics are being trained, and ground organization, landing fields and service stations are being developed all over the country, although slowly and on a modest scale.

What, then, are the difficulties which have so far stood in the way of rapid development of regular inter-city air lines in this country?

Briefly, the airplane finds itself today in that stage through which many new inventions have passed, and in which the article itself has reached a more advanced state of development than the facilities and accessories necessary for its completely effective use.

The modern commerical airplane has all the qualities requisite to passenger vehicles generally, whether land, sea, or air going, with the addition, naturally, of a few of its own. As for comfort, passengers are seated in chairs similar to those in a Pullman car, in cabins easily entered through full sized doors a step or two from the ground, protected from wind, cold and engine smells. They view the scenery through large windows. The motions of an airplane are far more gentle than those of any other vehicle, while sense of speed and vertigo are entirely absent in straightforward flying and there is no dust or dirt.

Safety and reliability under organized operating conditions are now such as to justify anyone in entrusting life and property to the air; according to the latest time-tables the regular passenger and freight lines in Europe are covering 22,000 miles per day.

Table 1, a summary of British Air Ministry weekly reports on the traffic between London and the Continent, shows some interesting figures. On the three routes operated, 3088 flights were started during the first 10 months of 1921, of which 91½ per cent were carried out in good order, which represents a distance of 700,000 miles flown and at least 6200 starts and landings made without one single passenger being hurt seriously. These figures are the more remarkable when taken into consideration with the very unfavorable weather conditions for which the region of the English Channel is notorious.

The United States Air Mail Service, which is operated over a series of route sections somewhat shorter in average length than the European lines, completed 95 per cent of the 6690 flights attempted during the first 9 months of 1921, in the course of which 1,332,000 miles were flown with mail. On the Cleveland-Chicago section the twenty-fifth successive week of 100 per cent performance was recently reported. However, it must be remembered that the Mail Service is supplied with a far greater number of airplanes and engines in proportion to the length of its routes than any private company striving to operate at a profit could afford, and also that, when carrying mail only, flights often can be successfully carried out under conditions which would be incompatible with the safety of passengers. The figures given do not, therefore, provide a satisfactory basis on which to judge the relative merits of equipment and personnel between the U. S. Air Mail and the European passenger lines, as far as regularity of performance is concerned.

TABLE 1 OFFICIAL STATISTICS ON THE AIR LINES BETWEEN LONDON AND THE CONTINENT

From January 1, 1921 to October 30, 1921. Approximate total mileage flown 700,000 miles. Not a single passenger killed or injured.

ROUTE	Distance in Miles	Number of Journeys	Passengers Carried	Journeys Carrying Mail	Journeys Carrying Freight	Journeys Completed to Schedule	Percentage of Journeys Completed	Type of Machines
Paris–London	240	1141	4581	435	787	1021	90	De Haviland Handley-Page Prëguet
London–Paris	240	1110	4521	317	407	1033	93	Farman S.P.A.D. Vickers
London–Brussels[1]	210	260	298	148	153	243	93.5	Farman De Havilland
Brussels–London[2]	210	226	353	177	173	201	89	
London–Amsterdam[2]	265	176	200	160	166	167	95	Fokker F-3
Amsterdam–London[2]	265	175	275	164	147	162	93	
Total	...	3088	10228	1401	1830	2827	91.5	=

[1] Service suspended owing to fire at Brussels aerodrome Sept. 28, 1921.
[2] Commenced operations April 14, 1921.

Finally, in judging the present status of the airplane as a means of transportation, the all-important question of operating cost must be considered. The first air lines started operations hopefully, on the assumption that their small first outlay, on the purchase of converted war planes at a fraction of the manufacturing cost, and the supposed imperative demand of modern business for speed above all things, would insure at least a paying business from the beginning. How sadly they were disappointed is clearly shown both by the history of the companies concerned and the rapid, if not yet quite complete, disappearance of these machines from the chief airways of Europe.

Large numbers of 3-seater machines, converted fast day bombers, were in use during the first year or two after the war, which showed a dead financial loss on every trip, even when loaded to full capacity which was by no means always the case. Large twin-engine bombers, capable of carrying about 10 passengers, solemnly ploughed their way daily between London and Paris and London and Brussels, more often than not less than half loaded, and at a prohibitive cost in gasoline and oil for their big engines. The fares charged had to be very high and the vicious circle was complete.

The technical results—mechanical reliability and ability of the pilots to make their way in bad weather in spite of the rather primitive meteorological and other ground services available at that time—were surprisingly good, but the financial results were disastrous and produced a great deal of adverse opinion.

[1] Netherlands Aircraft Mfg. Co., New York, N. Y., Fokker representatives in America. A.M.I.Ae.E.

Paper presented at the Annual Meeting, New York, December, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

It was not until the French Government heavily subsidized the French lines and enabled them to make a cut of 40 per cent in their rates, that traffic began to increase; with this assistance, the old war types, uneconomical as they are, took on a further lease of life in France and are still widely used in that country. To enable the British companies to compete, the British Government assisted them by financing the acquisition of modern commercial planes on a repayment basis, and guaranteed a profit. The effect of these steps on the traffic itself is well shown by Table 1. In the meantime the principal constructors had given their serious attention to the problem of increasing the carrying capacity and reducing the running costs and the new machines showed a remarkable improvement in this respect.

It is interesting to note the successive steps toward this realization of the chief commercial requirement, the carriage of greater loads at less expense. Just before the dissolution of the pioneer concern—The Aircraft Travel & Transport Co.—a desperate effort was made to improve matters in this respect. Operations were placed in the hands of traffic experts pure and simple, who, quite justifiably, at once tried to increase the service obtained per week from the equipment in hand, such as it was. Undoubtedly this effort provided a vast amount of data on constructional details such as accessibility of engine installations, ease of repair and all matters which would become especially prominent as more work in a given time was demanded of each airplane as a unit. The results only emphasized more respects in which the coming commercial designs had to show improvement over the converted war types, aside from carrying capacity and load space.

The requirements having thus become clearly established, the designers set out to fulfill them. After the 360-hp. DH16, really a converted DH4, carrying four passengers in very cramped quarters, and subsequently the BAT, FK26, which carries a slightly greater load with the same horsepower in a good-sized cabin, this progress in design was very marked in the 450-hp. DH18, carrying eight passengers which was very soon followed by the Fokker monoplane with five passengers for 185 hp. With these the useful load carried per horsepower had advanced from 4 lb. to 8 lb., or an improvement in commercial performance of 100 per cent. The internally braced monoplane, in which the airplane finds itself practically reduced to its essential parts, lifting surface, body, chassis and controlling organs comprising the entire structure of the machine, has opened up fields of study in the matter of wing design which promise still further progress in this direction. Within recent months several new designs on this principle have appeared and are in successful operation, which again show an advance in carrying capacity. Notable among these are the new DH29 and the new Fokker F4, which carry from ten to twelve passengers and considerable baggage with engines of 400–450 hp., the useful load carried per hp. thus having now advanced to 9 lb. Roughly, this means that such airplanes can carry a load of more than one ton in passengers and freight a distance of 600 miles in 6 hours at a fuel cost of $48, or $^3/_4$ of a cent per passenger mile.

The few figures given go to show that the airplane, even in its present state of development, is by no means a hopelessly costly means of transportation, provided that facilities for its exploitation are developed to a sufficient extent so as not to entail the addition of entirely disproportionate overhead charges to the actual running cost, charges of a character with which no other form of transportation has to contend or is able to bear. In the following paragraphs a few of the factors governing these charges are discussed.

The Selection of Routes

What has been said gives an indication of the airplane's present capacities and also of the trend of development in the near future. The next question is, obviously, where can it be put into regular service with a reasonable expectation that that service will become truly a public utility and receive sufficient support to thrive as a commercial venture?

It may be argued that eventually air traffic will have its place in the scheme of things alongside the older and slower means of transit, wherever traffic of any kind—or at least long distance traffic—exists. However, it is obvious that in choosing the routes to be operated during the introductory period very great care will have to be taken to select those on which the air lines are likely to justify their existence within a reasonably short time. Such routes may be fairly clearly divided into two categories. First, there is the route between commercially or politically important points, of which the development has been so rapid that transportation facilities have been unable to develop proportionately. The new world is full of such opportunities for the airplane, the only vehicle which is practically independent of geographical obstacles and does not entail the laying down of a permanent right of way.

Second, there are routes on which terrestrial tranportation facilities are very highly developed and the volume of traffic very great, but where at the same time communication is retarded by natural obstacles which do not affect the airplane to any considerable extent. Chief among these are mountains and intervening stretches of water entailing either transshipment or circuitous routes.

In either case, the decision that the establishment of air communications is a justifiable venture can only be made after careful study of existing transportation facilities and local conditions. The full support of the foremost industrial and business interests in and around the terminal cities must be obtained; and extensive preliminary canvassing and propaganda work are essential with a view to enlisting coöperation by the community in the establishment of air terminals and other facilities analogous to those provided for shipping as well as to insure patronage once the air line is in operation.

The public has to be taught how to use the airways; even with air lines in full operation a great deal of publicity work and effective advertising will be necessary to show the business man just how to combine the new transport facilities with the older ones in order to take full advantage of the airplane's speed. This is especially the case as long as night flying is not practicable, or rather, not organized and regularly carried out, thereby necessitating the coördination of train- and air-service schedules for long distance transportation.

Especially in the early days, the European lines suffered from lack of appreciation of the value of this educative publicity, a fact which contributed immeasurably to their difficulties in obtaining satisfactory loads. Both by this example and the far greater development of the science of advertising in this country, the coming American lines should have a considerable advantage over the European pioneers in this respect.

In the establishment of the first lines many similarities to the early days of railroading will be found, but many of the trials of the latter, both technical and financial, may be avoided. Compared with the railroad, the capital outlay involved in the air line is fractional; the non-requirement of permanent tracks involving the possession of immense tracts of land, will always be among the chief advantages the airplane possesses over any other means of overland transportation.

Ground Organization

Nevertheless, real estate values effect the increasing commerical use of the airplane to a considerable extent. There is probably no other single factor which has been so effective in retarding the general use of aircraft in this country as the lack of landing fields. Such privately owned flying fields as there are, are in only too many cases small, with obstructed surroundings and inadequate for highly loaded commerical craft. The military fields, which in Europe form the backbone of the airways, are few in the U. S., even including those abandoned after the war; also they are generally located just where the ground happened to be naturally suited for training in flying, far removed from large cities. In Europe important centers were liable to attack by enemy airplanes and defensive squadrons had to be stationed close at hand. Even in the case of the European capitals, however, the air ports now established on these old military fields are in most cases much further away from the cities than is desirable for commercial flying. If two hours have to be spent in transportation to and from the airports, in order to make a $2^1/_2$-hour journey by airplane, the saving of time over the railroad, at least where the latter provides an efficient and direct service, is practically lost, and the air line is not likely to flourish.

This problem is admittedly in most cases difficult of solution. The nearer the center of a town, the more valuable land becomes;

however well financed, the cost of such land suitable as an air port is not one which a new transportation company, which has yet to develop a popular demand for its service, can be reasonably expected to bear. The analogy with docks and harbors, of which the initial cost is borne by the city treasury, is obvious, but it is also demanding much from a city's foresight and enterprise to expect it to lock up a great amount of capital in reserving large tracts of valuable land near the business center, of which—especially at first—very scant use will seem to be made. As traffic develops, increased landing fees, hangar rents and other dues will improve the immediate financial aspect, until the time, which may not be so far distant as to be visionary, that long distance airliners will land on platforms covering the stations, yards and part of the tracks of the local railroad lines or even several city blocks.

To a layman, it would seem that in this question of reserving centrally located tracts of land as airports for a number of years there may be much to interest real estate manipulators.

The arrangement of emergency landing fields at short distances apart, along the routes, should not present any difficulties. Their preparation may involve the removal of a few trees and other obstructions and the erection of suitable markings as a guide for pilots when in difficulties due to weather or mechanical trouble, but otherwise they can retain their normal functions if meadow land is selected.

A most important part of the ground organization is the provision of a specialized and adequate meteorological service. A considerable development of the existing Government meteorological institutions or weather bureaus will be necessary, since the information obtainable at the present time is of very little use for air navigation. In Europe, government weather experts and radio services are installed on the principal airports, and reports are obtainable hourly. In England it was so well recognized that air navigation was bound to develop the knowledge and organization of meteorological work, that shortly after the war the existing government meteorological office was placed completely under the control of the Air Ministry.

Such further auxiliary services as directional radio and beaconing the airways by night, will eventually all have to be recognized as a public service and undertaken by the Government; the pooling of facilities by different railroad companies may be a matter of private arrangement and not the concern of the public, but the following of organized airways and the picking up of radio signals will automatically become a public right.

Legislation and Insurance

As is the case with any form of transportation, the perfection of organization, mechanical reliability and standing of personnel ought to be reflected clearly in the terms on which equipment passengers and freight are accepted for insurance by the large companies, and it may be fairly regarded as illustrative of the condition of commercial flying in this country that the state of affairs in aircraft insurance is far from satisfactory.

At present the position of an insurance company called upon to quote on aircraft risks is not enviable. The entire absence of any legislation to place responsibility for even the most elementary consideration of public safety, by controlling the efficiency of aircraft and ground organization, combined with the scarcity of such ground organization in the form of landing fields and auxiliary services, would induce any company to keep clear of taking aviation risks for the present, were it not for the necessity of obtaining experience and statistics as a basis for the business which the development of air transportation on a large scale will eventually offer. As it is, the present state of the aircraft insurance market may justifiably be described as chaotic. Again, risks have been accepted which should never even have been considered, and the consequent losses duly paid, while on the other hand premiums have been quoted which must have been based on a considerable "factor of ignorance," being, apparently, out of all proportion to results already been obtained elsewhere under conditions sufficiently similar to those involved in the proposal.

The institution of a system of registration and inspection of aircraft and pilots by the Insurance Underwriters Laboratories is a great step in the right direction. To make the system fully effective, it is to be hoped that legal confirmation of the powers of that body will soon follow. The assignment of such technical duties to a semi-public institution, instead of to a Government department—which principle has a strong precedent in the case of shipping in Lloyds—is in many respects preferable. The rapid development both of the airplane and its application, may necessitate frequent and urgent changes in existing regulations, with which necessity it will be difficult to keep pace if technical details are incorporated in Federal laws.

The effect which proper legislation will have on the financial stabilization of air transportation in general, both through the creation of reasonable insurance facilities, and through the definition of the legal status of the airplane and that of its operators, is well illustrated in the case of passenger liability. When legal liability for the safety of passengers and third parties is determined, insurance against these risks will become possible. At the present time the risk cannot be determined. Possibly claims on one accident are limited to the value of the machine to which it hapened, as under Admiralty Law (which presumably already applies to seaplanes); possibly they are not. The operators of aircraft can only print a strong cover against liability on their tickets, or perhaps incorporate each plane as a separate company, and find comfort in the safety statistics. It is to be noted that the latter have already led the English insurance companies to strike the clause refusing flying risks from the ordinary life policies.

With the development of the air lines, the insurance rates will undoubtedly always serve as an excellent index on the effectiveness of whatever legislation or regulation there may be and of the soundness of air transportation as a public service and a business.

A Few General Conclusions

In reviewing the possibilities of an early and successful development of air lines in this country it is imperative that the European pioneering in this sort of traffic be closely watched and that the greatest possible use be made of the experience and statistics it has provided. Except as regards purely technical matters, however, these should be applied to American projects and prospects with great circumspection and the difference in political and economic conditions be kept clearly in view. The case of direct government subsidies is a striking one, these having been largely responsible for the development of traffic in Europe, while they are practically unthinkable in this country. What is wanted from the Government here is what may justifiably be looked upon as its natural obligations, that is, the provision of facilities of all kinds, as outlined above. That direct financial assistance ever fosters true progress and new developments no one believes. Human nature being as it is, the tendency is inevitable to regard official aid as manna from Heaven and let things take care of themselves; not to speak of the countless opportunities for favoritism, intrigue and worse, that it entails. Abroad, conditions are different in that respect. It should not be forgotten that most European trunk-lines are international in character and that national pride and political expediency are potent factors in matters of this kind. Also that the various governments have a much greater interest in the maintenance of a commercial air-fleet as well as a ground organization that can be requisitioned at short notice in case of need, than will ever be the case in this country.

Apart from their questionable desirability on the grounds touched upon above, direct subsidies should not be *necessary*. The variety of geographical and economic situations which the United States offers within its own boundaries will provide plenty of scope for financially successful commercial flying operations, if properly taken in hand with proper equipment. The moment that air transportation shows its inherent advantages to the business men of America it will be used on a scale which will leave European traffic figures far behind from the very start. The history of the automobile is a good example.

The amount of traffic, both in passengers and express matter from which the air lines will be able to draw their share, is great. The "magnificent distances" to which President Harding alluded in his recent message on this subject automatically insure the saving in time that makes air travel pay.

But the first steps are always the hardest and official support in some practical form for operators and builders of commercial

(*Continued on page 111*)

The Strength of Airplane Rib Forms

Description of An Investigation to Determine the Strength of Plywood Webs, with Lightening Holes Arranged as in Airplane Ribs

By D. T. BROWN,[1] PHILADELPHIA, PA. AND R. J. DIEFENBACH,[2] BUFFALO, N. Y.

As illustrating the problem of the strength of materials entering into airplane construction and the degree of research necessary for their proper solution, the following report of an investigation carried out at the United States Forest Products Laboratory will be of interest. In the design of airplane ribs the prime requisite is to obtain the maximum strength with minimum weight of rib. Two factors enter into the problem: the form or design of the rib and the method of its construction in relation to the grain of the material. It will be seen that the investigation reported was conducted in a very complete manner and that conclusions of great value in the design of this essential part of the airplane are brought out.

THE great difference in the strength properties of wood along and across the grain has long been recognized as one of the features restricting its use in structures. Tests made by the U. S. Forest Products Laboratory show that the approximate ratios of the strength properties in these two directions are: The modulus of elasticity across the grain is one-fifteenth of that along the grain; the tensile strength across the grain is one-twentieth of that along the grain. These ratios do not apply exactly to any individual species, since different species vary largely in this respect.

A very material reduction in the differences along and across the grain is obtained in ply-wood construction by gluing together successive sheets of veneer with the directions of the grain at right angles, and varying the proportion of grain and number of plies in the two directions.

In the design of airplane ribs the prime requisite is to obtain the maximum strength with minimum weight of rib. This series of tests has been made to find the strongest form of rib, taking into account the two factors above mentioned by placing the grain of the veneer 45 deg. to the vertical. In modern practice the face grains are vertical and the core horizontal. Most of these tests, however, were made with the face grains parallel and at 45 deg. to the vertical with one core at 90 deg. to the face grain.

Description of the Materials Used

Birch veneer $^1/_{28}$ in. thick was used. In order to obtain a fair comparison in the tests, all of the veneer used in making up the ply-wood was cut from one log. The veneer used consisted entirely of heart wood, the log being sufficiently large to eliminate the need of using any sap wood. No pieces containing knots or checks were used. The veneer had been in store for some time and was well seasoned.

The veneer was glued together into three-ply ply-wood by the Theodore Schwamb Company, which specializes in such work. The ply-wood was cut into specimens $4^1/_2$ in. wide by 18 in. long. As already noted, the face grains were parallel and in most of the tests at 45 deg. to the vertical, and the core was placed at 90 deg. to the face grains. One of the chief objects of these experiments was to determine the effect of making the web of a rib from plywood with the grain at 45 deg. to the chord, so that the grain runs parallel to the directions of the principal stresses at the neutral axis of the web.

The ply-wood now used in practice in airplane ribs is made up with the face grains parallel and usually vertical and the core horizontal. This method has proved generally stronger than if the reverse disposition is used, that is with the face grains parallel and horizontal and the core vertical.

In order to prove the superiority of the method suggested in this paper some specimens were made according to modern practice and tested under like conditions.

The Methods of Testing Employed

In all cases the specimens were tested as cantilevers at a 15 in. arm. Spruce flanges $^1/_4$-in. square were glued on the sides of the specimens to prevent lateral collapse as a whole. In order to insure a definite length of cantilever arm and also for holding purposes, a hardwood block, $^1/_4$-in. by $3^1/_2$-in. square was glued on each side at one end of the specimen. The specimens were held in a wide-jawed vise; knurled jaws were used to avoid slippage. The load was applied by a smooth-acting screw jack, and the force was measured by placing the screw jack on a small platform scale which could be read accurately to one pound. Upon the head of the screw jack, a round steel bar was placed. This insured a concentrated load at the end of the cantilever.

The Results Obtained

In the rectangular type of lightening hole with constant web thickness and variable fillet radius, it was found that below $^3/_4$ in. radius the fillet was of but little use.

The specimens for the tests made in the next group, were made with variable radius of fillet using lattice construction. A maximum of 283 lb. was reached in this group. Since 181 lb. was the maximum force applied at the end of a 15-in. cantilever with vertical grain and rectangular holes, and since it has generally been found that lattice design with triangular holes is little, if any, stronger than that involving amply filleted rectangular holes, if vertical or horizontal face grain is used in both cases[1] the advantage of diagonal-grain design for the lattice form appears to be clear. The comparison between the best case with diagonal grain and lattice design and the best arrangement of rectangular lightening holes with vertical grain expressed in percentage change from the second to the first is as follows:

Radius of fillet, in.	Increase or decrease of area not cut out (change of web weight, per cent)	Increase or decrease of force applied to produce failure, per cent
$^1/_4$	−29	+12
$^1/_2$	−2	+29
$^3/_4$	+2	+56

The advantage of the lattice construction is obvious. Inspection of Table 1, where the ratio of strength to area of web is given, indicates

TABLE 1 RATIO OF STRENGTH TO AREA OF WEB

Type of Construction	Variable	Width of Vertical or Diagonal Web Members, in.	Radius of Fillet, in.	Character of Failure	Distance between Center of Cross	Percent of total Area Cut Out	Per cent of Area Remaining	Force Applied at end of 15-in. Cantilever, lb.	Force ÷ Per cent of Area Remaining
Rectangular lightening holes	Radius of fillet	$^1/_2$	0	Shear	....	76.1	23.9	50	2.09
		$^1/_2$	$^3/_4$	Shear	....	73.1	26.9	55	2.04
		$^1/_2$	1	Shear	....	70.7	29.3	64	2.18
		$^1/_2$	$1^1/_4$	Shear	....	67.7	32.3	97	3.00
		$^1/_2$	$1^1/_2$	Shear	....	63.9	36.1	134	3.71
Lattice	Radius of fillet	$^5/_{16}$	$^1/_4$	Compression	....	74.6	25.4	202	7.95
		$^5/_{16}$	$^1/_2$	Compression	....	70.3	29.7	233	7.85
		$^5/_{16}$	$^3/_4$	Compression	....	63.3	36.7	283	7.71
Lattice	Thickness of web	$^5/_{16}$	$^1/_4$	Compression	....	74.6	25.4	202	7.95
		$^3/_8$	$^1/_4$	Compression	....	73.0	27.0	238	8.82
		$^7/_{16}$	$^1/_4$	Compression	....	71.5	28.5	256	8.98
		$^1/_2$	$^1/_4$	Tension	....	69.9	30.1	278	9.24
Crossed lattice	Distance between center of cross	$^1/_4$	$^1/_4$	Compression	7 in.	70.9	29.1	201	6.90
		$^1/_4$	$^1/_4$	Compression	6 in.	69.3	30.7	230	7.49
		$^1/_4$	$^1/_4$	Compression	5 in.	67.2	32.8	280	8.54
		$^1/_4$	$^1/_4$	Flange	4.5 in.	65.7	34.3	295	8.60

that that ratio is little affected by radius of fillet, the smaller radii having a slight advantage.

The ratio of strength to weight is steadily improved by increasing the width of the diagonals, although the improvement is slow for widths of $^3/_8$ in. or more.

A crossed-lattice arrangement with a spacing between the crosses

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[1] Sales Dept, American Radiator Co.

[2] Student Sales Engineer, Worthington Pump & Machy. Corpn. Jun-Mem.Am.Soc.M.E.

Abstract of paper presented at the Annual Meeting, New York, December, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Bulletin Airplane Engineering Division, U. S. Army, September, 1918.

of 1.5 times the depth of the lightening hole appears to be approximately equal to the best straight-lattice arrangement. It is difficult to make a satisfactory direct comparison, as the required depth of the horizontal portions of the web, above and below the lightening holes, varies with the distance between lattice members. With due allowance for this fact, a very close spacing of the crosses seems to be best.

With forces in excess of 300 lb. the flange fails by shearing. In the crossed-lattice construction true shear failure of the diagonals never occurred. The compression members are supported by the tension members in such a way as to decrease the free length of the column under compression.

In connection with this crossed-lattice group some specimens were tested with the compression member left out in every other cross. This arrangement is palpably inferior to the straight-lattice or continuous crossed-lattice. It was found that the crossed-lattice type did not stand up so well relatively with web thickness of $^3/_{16}$ in.

A continuous cross lattice spaced at .3 in. with vertical grain, carried 214 lb. Even this design is far better than that with rectangular holes.

Finally a test was made with no area cut out and it failed by buckling of the flange at 325 lb.

It was observed in the tests made that there was but little deflection with both the straight lattice and cross-lattice type. The deflection with the rectangular type was much more pronounced.

PROGRESS IN FLYING DISCUSSED

PRACTICALLY all of the discussion at the session was on the commercial aspects of aviation. Mr. Joseph A. Steinmetz, chairman of the Executive Committee of the Aeronautic Division, discussed the present status of aerial development, describing the progress in Europe from first hand observation this summer, and the progress in this country, especially in the South, where commercial lines are about to be inaugurated. In the construction and development of aviation throughout the world, he saw tremendous possibilities for the art within the next few years.

Prof. E. P. Warner, Massachusetts Institute of Technology, who presided at the session considered that our fundamental purpose is the development of commercial flying, which has ceased to be a problem of design and construction, and has become one of publicity.

Lieutenant E. E. Aldrin, secretary of the Division in the discussion of Mr. Noorduyn's paper, detailed his experiences on the London to Paris Air-Line this summer. He said there was no question of the advantage of commercial flying, if only from the point of saving time.

Commercial flying in Europe is now developed to the point that the passenger uses a time-table just as he does for a railroad train.

Then again, the comforts of the air journeys are a favorable consideration.

Mr. Foster Russell[1] asked a number of questions regarding the cost of carrying mail and Major Lent answered him, pointing out also that there was much greater promise of commercial success in carrying goods, such as mail, than in the transportation of passengers. A study had been made of the profits to be derived. The commercial companies acknowledged that they were after express business and other high class matter, and would be glad to avoid the risk of carrying passengers.

Mr. Noorduyn answered a question of Mr. Russell's that the Government would gladly turn over the carriage of mail to private transportation companies provided that they could show satisfactory prospects of rendering good service, but that the Congressional appropriations would not allow the payment of a higher rate for air-line transportation than by any other means.

There was considerable discussion of the possibilities of aircraft landing fields, and Mr. Steinmetz related his experience in getting such fields. He said the way to do it was to get a City Plan Conference to set aside a big fair ground, or a county exposition field, and then get an engineer to go over the layout with them and put in an aircraft landing field. Later on they could be shown their great wisdom and foresight in providing for an air port for world traffic.

[1] Spokane, Wash. Jun-Mem.Am.Soc.M.E.

Mr. Russell, thought the main problem of commercial flying was the provision of a machine which could be made and sold very much like a Ford automobile is sold, something that could be sold to farmers. He also gave his experiences with landing fields, reciting some of the cases encountered in trying to get such fields. He thought the best thing to do was to get airplanes in the air and the landing fields would come.

Several of the speakers present discussed the feature of safety in commercial flying, and there was a general agreement that great publicity should be given to the relatively small amount of risk, added to the extreme pleasure of this form of transportation.

Among those who took part in the discussion was Mr. Charles Manly, past president of the Society of Automotive Engineers, and a well-known figure in the practice of aviation. Mr. Manly outlined in great detail the things that would have to be done to make commercial flying popular with the public, and to make possible the development of commercial aviation companies on a profitable basis, without which there could be no commercial flying. The only other thing to be met was that a machine should be provided which could be bought for a reasonable price.

ELASTIC PROPERTIES OF SMALL-SIZE WIRE CABLE

(*Continued from page 106*)

TABLE 3 AMOUNT OF INCREASE IN ELASTIC LIMIT OBTAINED ON THE CABLES TESTED

Type	Size	Increase in Elastic Limit, Lb.	Per Cent Increase over Original Elastic Limit
19	$^7/_{32}$	2000	62
	$^3/_{16}$	1000	33
7 by 7	$^3/_{32}$	250	63
6 by 7	$^9/_{64}$	240	30
7 by 19	$^1/_8$	400	36
	$^{11}/_{32}$	2000	33

CONCLUSIONS

The modulus of elasticity of small-size wire aircraft cable varies from 15,000,000 to 28,000,000, depending upon the size and types of the cable. The 19-wire cable has undoubtedly the highest modulus and the 7 by 19 cable probably the lowest. The maximum difference between moduli of specimens of the same size and type of cable may be as high as 3,000,000.

The modulus of elasticity may be raised by loading the cable below the elastic limit. The greatest increase is obtained on the 7 by 19 type and may amount to 6,500,000.

Resting the cable did not seem to have any definite effect on the modulus.

The elastic limit may be raised by loading the cable a little beyond this point. The maximum increase obtained amounted to 63 per cent of the original elastic limit.

The complete paper contains curves of all the runs in the different sizes, also complete logs of the tests.

AIR LINES AND SOME OF THEIR PROBLEMS

(*Continued from page 109*)

aircraft would do much to ease the situation. Contracts for the carriage of mail at rates, commensurate with the increased rapidity of delivery, could be given to reputable air transport concerns whose facilities for carrying out their engagements would bear investigation. Congress can make this possible as it did when mail coach and couriers were replaced by the railroad.

Another valuable form of subsidy would be the development of all purely war-types of machines in the shops of commercial builders and a system of awarding to designing firms paying production contracts for their own original products. Thereby would the aeronautical industry regain a good deal of the confidence which apparently it has lost. And the blending of the newest ideas in aeronautical warfare or defense with the most modern developments in efficiency and reliability would go a long way, in the writer's opinion, toward the reëstablishment in this country of supremacy in the air.

A Session on Fuel Economy

Discussion of Four Papers at A.S.M.E. Annual Meeting Brings Out Many Experiences in Economic Boiler and Furnace Operation, Leading to Great Fuel Savings

THE Fuel Waste Session of the Annual Meeting of The American Society of Mechanical Engineers, held Thursday morning, December 8, 1921, attracted a large audience and a voluminous discussion on account of the popular interest in the subject. Prof. L. P. Breckenridge, Chairman of the Fuels Division, presided at the meeting. The papers presented were, Boiler Plant Efficiency, by Victor J. Azbe; Boiler and Furnace Economy, by D. S. Jacobus; Fuel Saving in Relation to Capital Necessary, by Joseph Harrington; and Fuel Saving in Modern Gas Producers and Industrial Furnaces, by W. B. Chapman. All these papers have already been published in MECHANICAL ENGINEERING.

All Concede Mr. Azbe's Statements Sound

J. M. Spitzglass[1] quoted the following paragraph which, he said, he believed to be the keynote of Mr. Azbe's paper:

> Nowhere is there such an opportunity for good return on the investment as in the boiler house, where a few dollars properly applied can perform wonders. But there are also properly designed plants that are wasteful, due to human inefficiency, and to such beliefs as that stokers are a failure, high CO_2 harmful, economizers a poor investment, superheated steam impractical, etc. It is the man who designs or operates who is at fault, rather than the equipment. The fireman is more important than the stoker and a good fireman will obtain good results from a poor stoker. But since good firemen are scarce, it is preferable to purchase equipment which is as nearly foolproof as possible.

Wm. S. Aldrich[2] wrote suggesting that in grading combustion performance, a percentage scale with maximum possible CO_2 as 100 per cent be used.

John Clinton Parker[3] spoke in commendation of the paper. He pointed out the necessity for honorable design, honorable testing and honorable operation in the engineering world.

R. Sanford Riley[4] considered the paper absolutely sound, saying that nothing sounder had been expressed before the Society than the author's ideas on differences in conditions of operation.

D. S. Jacobus[5] said he wished to add that, in getting the most out of a boiler plant, more must be considered than the efficiency of the boiler and the efficiency of the plant in general. Much of the saving to be made in boiler plants is often not in improvements in the boilers themselves, although many times such improvements can be made, but by such means as changing the system of heating feedwater, or of providing hot air, or of adjusting the heating system.

David Moffat Myers,[6] speaking in the spirit of Dr. Jacobus's remarks, told of making a saving of 15 per cent in a plant without making a single change. The firemen, conscious of his presence, had paid better attention to their jobs, with the resulting saving. In other plants he had found that merely by requiring simple records kept, economy was improved through the psychological effect on the firemen. He also spoke of the necessity of providing the firemen with an incentive for good work. Efficiency in a plant, he said, was a combination of the efficiency of the men and the efficiency of the machine.

C. H. Smoot[7] asked who was responsible for low efficiency in boiler plants—the manufacturer of the boiler, the manufacturer of the stoker, the operator, or the fireman? If it is possible to increase the efficiency of boilers from 50 to 80 per cent, as stated by the author, it seemed to him that such an organization as the Society should see to it that such savings were made.

C. Harold Berry[8] assumed that most of the statements of the author's paper referred to small plants, and not to central stations. He also pointed out that the tests reported in Table 3 of the paper were made at different ratings, which might account for some change in the efficiency. The author's statement that most stations had too many boilers did not apply to central stations.

In reply to Mr. Berry, the author pointed out that the tests referred to were run in each case at maximum capacity, showing that improved conditions resulted in increased capacity as well as increased efficiency.

Dr. Jacobus' Paper Characterized as Filled with Wisdom

W. F. M. Goss[9] characterized the paper as a concise statement of significant facts and a monument to the industry and scientific skill of its author. He has long had a part in the development of this field of engineering research, and much that is common knowledge today, has come through the painstaking processes which he has inspired and promoted. Underlying this paper therefore are activities incident to his fruitful life.

Edward N. Trump[10] wrote congratulating the Society on having received such an able paper as that of Dr. Jacobus, saying that it was full of the wisdom of long experience. A survey made by the Fuel Administration during the war had shown that the average efficiency of plants in the State of New York, even including the large plants operating at 80 per cent efficiency, would not be greater than 50 per cent.

While we should study the investment factor, he said, in determining whether or not to replace an inefficient plant, we must remember that the supply of coal in this country is not inexhaustible and will always increase in cost, and we owe something to posterity. We should be content to take a low rate of return on our capital, expecting other advantages which are more difficult to calculate.

He dealt with such questions as economizers, corrosion, high boiler setting, operation of boilers at high rating, furnace volume, and form of furnace as affecting the economy of operation.

Alex D. Bailey[11] wrote in reference to a statement of the author that air heaters are of special advantage where low-grade fuels are burned. While this may be true as stated, he said, it is equally true, particularly in the case of coal, that on account of the sulphur content, air heaters might operate at the greatest disadvantage.

So far as the personnel of boiler plants is concerned, probably the greatest need for education and missionary work is with managers and chief engineers who do not appreciate the importance of this part of power-plant operation.

Automatic systems for combustion control will never take the place of brains, and while these may function fairly successfully if left alone, their ultimate success would be improved by proper supervision and care.

To attract the right kind of men the conditions in the boiler room must be made attractive, and to get the best results proper equipment must be provided, so that the men with proper education and training can get the desired results.

R. Sanford Riley[12] wrote that we all agree that combustion should be completed within the furnace chamber. This requires volume and proper opportunity for mixing of the gases. He could not see, however, that efficiency is increased by the maintenance of a high temperature in the furnace between the fuel bed and the boiler. The maximum temperature due to combustion of the fuel will be obtained when there is high percentage of CO_2 without CO, or in other words, when there is a minimum of excess air accom-

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[2] Gary, Ind. Mem.Am.Soc.M.E.

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[4] Pres., Sanford Riley Stoker Co., Worcester, Mass. Mem.Am.Soc.M.E.

[5] Advis. Engr., The Babcock & Wilcox Co., New York, N. Y. Mem.Am.Soc.M.E.

[6] Cons. Engr., Griggs and Myers, New York, N. Y. Mem.Am.Soc.M.E.

[7] Engr. & V. P., Rateau, Battu Smoot Co., New York, N. Y. Mem.Am.Soc.M.E.

[8] Research Engr., The Detroit Edison Co., Detroit, Mich. Mem.Am.Soc.M.E.

[9] Pres., Ry. Car Manufacturers Assn., New York, N. Y. Mem.Am.Soc.M.E.

[10] V. P., The Solvay Process Co., Syracuse, N. Y. Mem.Am.Soc.M.E.

[11] Chief Engr., Stas. 1 & 2, Commonwealth Edison Co., Chicago, Ill. Mem.Am.Soc.M.E.

[12] Pres., Sanford Riley Stoker Co., Inc., Worcester, Mass. Mem.Am.Soc.M.E.

panied by complete combustion. The above condition represents, of course, the highest combustion efficiency and if Dr. Jacobus means "temperature of combustion" or "fuel bed temperature" when he says "furnace temperature," he could certainly agree with his statement. The temperature within the furnace chamber, however, need not be as high as this maximum temperature of combustion.

Elsewhere in the paper Dr. Jacobus mentions the large utilization of radiant heat, and he was much impressed with the statement that B & W boilers may absorb as much as 60 per cent of the total heat by radiation. It seemed to him that this large absorption by radiation is all to the good, and the consequent lowering of furnace temperature is one reason why it is so good. No compromise is necessary in this respect, except to secure ignition. With underfeed stokers there is no need to make any compromise whatever, and the best practice seems to be to expose the maximum area of tubes to radiant heat and thus hold down the furnace temperature. This transfer of heat by radiation is the direct route "from maker to user." There is then no middleman like brickwork to take toll and cause trouble. Convection can also be considered a middleman but does not require much attention or cause any trouble.

He suggested the theory that all boiler-furnace construction should utilize radiation to the maximum, and so hold furnace temperature down to the minimum. This theory has nothing to do with the temperature of combustion in the fuel bed, which of course should be the highest possible to correspond with the minimum of excess air.

E. L. Hopping[13] presented a written discussion referring to the design of furnaces for 1500-hp. Stirling boilers, with integral economizers, at the Delaware station of the Philadelphia Electric Co. Two considerations were kept in mind;

a That the furnace be made sufficiently large to allow for efficient operation at high rating without detriment to furnace walls or stoker parts

b That in case it was found desirable, after installation of the boiler, to change to some other type of fuel burning, the cost of such a change would not be prohibitive and that conditions would be such as to produce the highest economies.

The furnace as finally designed and built has a volume of 4.8 cu. ft. per rated boiler horsepower, or about 1½ cu. ft. per maximum developed horsepower, which is a rather high rating for stoker-fired boilers. These boilers were designed to operate at maximum capacities of about 300 per cent normal rating.

The results obtained in operation of these boilers have been very satisfactory and one condition which was not looked for has been secured. This is the practical elimination of the cinder nuisance at this plant.

Edwin B. Ricketts[14] discussed the subject of deformation temperature of furnace brickwork and methods of decreasing it by currents of steam or air or by circulating water through pipes in the brickwork. He also spoke of the lack of uniformity of size of furnace brick and methods of overcoming the difficulty.

A. A. Cary[15] pointed out the difficulty of separating the efficiency of the boiler from the combined efficiency of boiler and furnace. Notwithstanding the difficulties involved, he had found it desirable to determine individual efficiencies for boiler and furnace, and he explained his method. Dr. Jacobus' statements concerning firebrick he considered important, and he discussed carefully the problem involved in the design of the furnace, the selection of the material and the character of the clays used.

David Moffatt Myers urged the necessity of taking the matter of fuel conservation out of the hands of the individual, who will always be wasteful, and placing it with an authority powerful enough to insist upon economical utilization of this valuable natural resource, and suggested means by which this might be accomplished.

Wm. S. Aldrich offered some data covering experiences with a vertical water-tube boiler, installed originally as a waste-heat boiler and hence heated almost entirely by convection. The boiler was subsequently used with oil and with coal fuel, experiments showing that the conclusions of Dr. Jacobus were correct. This discussion spoke also of difficulties with brickwork at high temperature.

F. F. Uehling[16] wrote in amplification of Dr. Jacobus' statements regarding the presence of a small amount of CO with a high percentage of CO_2. Since the relation which the percentage of CO in the products of combustion bears to the loss up the chimney is a very interesting one, it occurred to him that a few curves showing chimney losses for different percentages of CO and CO_2 might prove not only interesting but also of value to engineers when the importance of CO content in flue gases is given their consideration. The curves were shown on the screen.

One of the most striking facts brought out in the curves is that there is not only a *loss* due to the presence of CO but *also a gain*, and the net magnitude of the CO loss is their difference. In other words, the effect of CO on chimney loss is twofold, one positive and the other negative, and the resultant actual CO loss can be determined by their algebraic summation. Furthermore the net effect of CO on the chimney loss may be plus, minus or zero, depending upon the conditions obtaining.

What actually takes place when CO is present is:

First, a loss results due to the unliberated heat in the CO itself, that is to say, the additional heat that would be available if the CO in the products of combustion had been oxidized.

Second, a gain occurs due to the fact that the more CO there is in the products of combustion for any given percentage of CO_2 the less will be the weight of the products of combustion per pound of carbon burned, and consequently the less will be the sensible heat dissipated by the flue gases as they leave the boiler.

John A. Stevens[17] spoke of the arrangements at the new central power station at Paris for preheating the combustion air to 190 deg. fahr. Another system has been devised for preheating to 170 deg. The proper temperature seems to be between 170 and 190 deg. fahr. The preheaters consist of a series of plates beyond the economizer, through which the air for combustion travels in one direction and the exhaust gases in another. The heater can be easily cleaned, both inside and outside.

Dr. Jacobus submitted additional matter after the meeting in which he said that the statements in his paper respecting the influence of the amount of boiler heating surface exposed to direct radiant heat from the fire on the efficiencies should be amplified. Where some portions of the fuel bed are much hotter than others a higher efficiency may be obtained by absorbing the maximum amount of radiant heat directly from the fuel bed rather than by mingling the gases within the furnace and afterwards passing them to the boiler. In general, however, the higher the furnace temperature the higher the efficiency. This part will be more fully covered in his closure.

Mr. Harrington's Subject a Public Affair

Walter N. Polakov[18] opened the discussion of Mr. Harrington's paper by emphasizing the fact that the conservation of our resources is in reality a public affair. Machinery, boilers and stokers, furnaces, instruments in the boiler room are of little importance unless the human element is back of them, and unless the intelligence is present to make use of what is available. The fact that daily performance does not equal test performance is due, he said, to four things: First, monotony, which is absent from test conditions; second, stimulation always present under test conditions; third, lack of coördinated brain and manual effort, as is essential in tests; and fourth, the close watch on all conditions which must be maintained during the test. It is important to increase the interest of the power-plant personnel in the use of instruments and to train them properly to observe the indications of these instruments. Whatever instruments are necessary, he said, usually pay for themselves within a short time.

T. A. Marsh[19] called attention to some changes made in the

(*Continued on page 118*)

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[15] Cons. M.E., 95 Liberty St., New York N. Y. Mem.Am.Soc.M.E.

[16] General Mgr., Uehling Instrument Co., New York, N. Y. Mem.Am.Soc.M.E.

[17] Cons. Engr., Lowell, Mass. Mem.Am.Soc.M.E.

[18] Cons. Engr., New York, N. Y. Mem.Am.Soc.M.E.

[19] Ch. Engr., Green Engrg. Co., East Chicago, Ind. Mem.Am.Soc.M.E.

National Research Council to Coördinate Research Throughout Country

With Assistance of All Research Agencies, Complete List of Investigations to be Kept—A.S.M.E., in First Annual Research Conference, Considers Means of Covering Mechanical Engineering Field

A MECHANICAL Engineering Advisory Committee for the Division of Engineering of the National Research Council has been formed within the organization of The American Society of Mechanical Engineers, with the Society's Standing Committee on Research as a basis. The contemplated program is described in the following article by Alfred D. Flinn, chairman of the Division of Engineering, who detailed the plan at the Annual Meeting of The American Society of Mechanical Engineers, at a Research Conference held on the morning of Thursday, December 8, 1921.

MECHANICAL ENGINEERING ADVISORY COMMITTEE FOR DIVISION OF ENGINEERING

By ALFRED D. FLINN, NEW YORK, N. Y.

MECHANICAL engineers make use, in some measure, at some time, directly or indirectly of many results of scientific research. There are, however, certain problems requiring scientific and engineering investigation which fall within the field regarded as peculiarly that of mechanical engineers. Among these, by way of example, may be mentioned problems relating to heat transfer, fatigue or progressive failure of metals, lubrication, cutting of metals, heat treatment of metals, welding, fuel economy and properties of steam.

Fields requiring research related to engineering are numerous and broad; the corresponding fields of application are occupied by the societies represented on the Division of Engineering. These societies have close contact with practicing engineers and the industries. The Division consequently came to the conclusion last Spring, that it could render best service and most wisely select and control its activities if it had the guidance of an advisory committee, or board, in each broad field of engineering. Such committees or boards are therefore being organized or have been organized in civil, mining and metallurgical, mechanical, electrical, highway, and welding fields. In some cases two or more societies having kindred interests have joined in one advisory committee.

Of course, the Division can proceed no faster in the development of these advisory committees than the societies are disposed to progress, or the committees themselves are willing to go.

Functions which the Mechanical Advisory Committee is expected to perform in its several fields are:

1 To act as clearing-house, steering committee and coördinating agency, in an advisory capacity
2 To advise the Division in selecting the most promising and feasible researches and in organizing the research committees
3 To propose researches which would be of especial interest to the A.S.M.E. and the societies associated with it in the Advisory Committee
4 To consider ways and means suggested by the Division for the conduct of the selected researches
5 To serve as the connecting link between the Division and the Society or the group represented by the Advisory Committee.

The form and degree of organization may be adjusted to the desires of the Advisory Committee. The American Bureau of Welding is an example of complete and close organization. The committee representing the A.S.M.E., at its first meeting, held December 8, 1921, preferred informal organization, leaving organizational development to be made as needs become apparent. The functions in such a field may be performed in general through sub-committees, by correspondence. It will hardly be feasible to hold meetings of the whole Advisory Committee oftener than once a year, in conjunction with the annual meetings of the Society. It may be that in the future one session of each annual meeting will be given over to a program of papers, reports and discussions on research topics under the auspices of the Research Committee.

Sub-committes may be suggested by the Division from time to time as needs arise. The interests of the Advisory Committee will suggest others. Initiative on the part of the Advisory Committee is much desired by the Division. Permit the suggestion also of an interim committee of a few members to conduct the business of the Advisory Committee between meetings of the latter.

The National Research Council has thirteen divisions. Six are devoted to general relations—Federal, Foreign, States, Educational, Research Extension, Research Information. Seven divisions are devoted to technical research, including engineering, agriculture, medicine, and the mathematical, physical and biological sciences. The Division of Engineering is made up of representatives of ten societies, including all four national engineering societies, and a number of members chosen because of their interest and their prominence in engineering.

The Division of Engineering is a switchboard, or telephone exchange, or clearing house, to bring together from one extreme the man in industry who wants to see practical results and who is loath to put money into research even then, and the man at the other end, who is called the pure scientist, and the various grades between them. One great advantage of the Research Council is that in its many committees it is able to assemble these many points of view of pure research men and the "practical" industrial men, by personal contact and by correspondence. It often happens that information or a suggestion is picked up from committee associates which is very valuable—information in the different branches of chemistry, biology, physics, geology, engineering, medicine. This feature of the work of the Research Council deserves emphasis—the bringing together of minds in many lines of scientific and industrial pursuits and the possibility of getting one man to help another, often incidentally, even though the connection of their problems at first thought seems remote.

The Division (and the Research Council as a whole) needs close contact with the various main groups of engineers in order to know how it can serve them most effectively and most acceptably. Small groups of men working in the Research Council's offices, or in committees closely connected with those offices, cannot get the various points of view which are needed except from a large group like the Advisory Committee. But if a group like this exists and can be readily reached through its chairman and its sub-committees, problems can be referred to it and sound advice can be obtained on the willingness to support a given project, or reasons for modifying or declining the proposal. At least the Division can get the suggestions of men who have been working on that line, whatever it may be, or who are prepared in their establishments to undertake to advantage the investigation selected.

At the Grosslichterfelde Laboratory, near Berlin, there is a wonderful card catalog. It is reported to have been claimed that of all the questions that came to this laboratory, eighty per cent were answered by the card index. Some one in Germany or elsewhere had worked on the subject in question and those cards showed where the information was. Be it noted that the questions sent to this laboratory were supposed to require original research work. That is the value of having information or keys to information available and concentrated at one place. In its field the Division of Engineering seeks to become useful in that way for the various branches of engineering and allied industries. Much more broadly the Research Information Service at the Washington office of the Research Council is endeavoring to build up such a collection of keys to scientific information and research personnel for the scien-

tists and engineers of the country. It will require the aid of many men who are leaders in technology and science. Engineering Societies Library is coöperating.

Interesting reports, papers or discussions presented to the Division of Engineering are offered for publication to the member society most likely to be interested. Occasionally such statements are issued as bulletins of the National Research Council.

Not a few research projects have phases which interest more than one society. Fatigue of metals has both metallurgical and mechanical aspects and concerns the civil engineer besides. Welding enters the fields of mechanical, electrical, civil and mining engineering, in addition to being a metallurgical and physical problem and interesting the welders as specialists. Heat transfer affects all branches of engineering, but especially the mechanical, the heating and ventilating, the refrigerating and the automotive societies. Highway research concerns particularly the civil, automotive and mechanical engineers. These few incompletely stated examples but indicate and emphasize the need for such a clearing-house as the Division of Engineering.

Through the generous coöperation of the Engineering Foundation, the Division of Engineering has offices in Engineering Societies Building, 29 West 39th Street, New York, the focus of American engineering. The headquarters of the National Research Council is in Washington. Information in further detail will gladly be given in response to inquiries addressed to the office of the Division of Engineering.

PROCEEDINGS OF RESEARCH CONFERENCE

TO those who heard Mr. Flinn's plea for the coöperation of The American Society of Mechanical Engineers with the National Research Council in the attempt of the latter to place on file all the information available on research, and who also heard the discussions at the conference, there came the mental reaction that an enormous amount of research along parallel lines must be going on at any time and that there is really a lack of general information as to what research is really in progress. For in the comparatively small group—about fifty—gathered at the conference, men engaged in important work learned practically for the first time of the details or work with many similarities being conducted by others sitting almost beside them.

This fact must have impressed the chairman of the A.S.M.E. Research Committee, Prof. A. M. Greene, Jr., who conducted the conference, when he made the remark that "a Research Conference such as this should be held at least once a year. Today is only a starter. Our Standing Research Committee of five is not able to do this kind of work; the committee is at present busy on such subjects as lubrication, bearing metals, flow of fluids, heat transfer, steam constants, permanency and accuracy of engineering instruments, vibration of shafting, torsional stress, vibration stress, friction of glass. These subjects represent particular phases only, though the whole field of mechanical engineering is open to the committee and the Society.

"The National Research Council feels that the Society ought to be available to furnish information on any branch of the subject, but only by a much larger committee organization than the present can this be done. Therefore the suggestion was that there should be a committee of about thirty-five, which would be a kind of sub-committee of the Research Committee, and an advisory committee to the National Research Council."

Throughout the proceedings of the conference there was no objection in principle to this kind of organization. It was felt, however, that the organization should be more or less informal and flexible, and formed with the idea that it could be made available to the National Research Council at any time upon its request.

PAPERS PRESENTED AND DISCUSSED

To confine the discussion at the conference to definite subjects it had been arranged that four topics should be introduced. Two of these were technical papers: Elimination of Waste in Industry Through Research, by F. A. Wardenburg;[1] and Research in Leather Manufacture, by Arthur W. Thomas.[2] The other two were, respectively, Report of the Research Sub-Committee on Lubrication, and Discussion of Steam Table Research. While a number of valuable ideas were brought out in the discussions by the research specialists present, the account here given of the remarks made is confined as far as possible to the two things necessary for a successful liaison with the National Research Council: An indication of (1) the extent to which important work is being more or less duplicated in some other place; and (2) the probable degree of general publicity about research work in progress. The papers by Messrs. Wardenburg and Thomas are both condensed considerably to fit within the space of this special account of the Conference.

ELIMINATION OF WASTE IN INDUSTRY THROUGH RESEARCH

BY F. A. WARDENBURG, WILMINGTON, DEL.

THE prime object of business is the making of money, and if research work is to maintain its proper place in business, it must be conducted so that it will more than pay its way.

Perhaps in no other work is it more difficult to foresee the difficulties liable to be encountered, and research work is always approached in a spirit of optimism. As a consequence, the cost is almost certain to be underestimated, not infrequently as much as 50 per cent, and the saving is very liable to be overestimated. As the work progresses the solution of the problem seems always just "around the corner," and more and more expenditure is incurred until the final cost may be greater than the saving effected. This is particularly true of the development of new machines or processes, but to almost as great an extent with an improvement to something existing. The result may be that the research, instead of decreasing waste, adds to it.

From the standpoint of the permanent success of research work, every possible means should be adopted at the inception of a problem and at all times during its progress to make the proposition a commercial success.

As one of the methods of assisting in this, the following plan of a large corporation is outlined:

1 When it is desired that a research problem be undertaken, it is required that there be filled out an "Experimental Request Form" giving

- *a* Title of research problem
- *b* Process affected and plants to which applicable
- *c* Reasons for conducting research
- *d* Description of process or machine in use which research work is to improve or replace
- *e* Description of proposed improvement and how to be obtained
- *f* Estimated cost of research work
- *g* Estimated savings or other advantages, given in detail to show clearly how saving has been figured and estimated capital expenditure necessary to put results into production
- *h* Name of persons making suggestion or contributing major ideas
- *i* Necessary approvals by executives authorizing the work.

It is surprising the many research problems which seem very promising when discussed in abstract, but which fail to pass the test insured by the filling out of the above form.

2 The man having charge of the research is required once a month to make a complete review of the problem, stating:

- *a* Object of the investigation
- *b* Work accomplished during past month
- *c* Status of problem to date
- *d* Probability of successful outcome and any new developments having a bearing on the application of the work commercially, if successful
- *e* Further work proposed in immediate future.

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[1] Asst. Chief Engr., E. I. du Pont de Nemours & Co., Wilmington, Del. Mem.Am.Soc.M.E.

[2] Asst. Prof. Food Chemistry, Columbia University, New York, N. Y.

3 Where it is apparent that the cost of conducting a research problem may be greater than the appropriation, an additional appropriation must be secured, at which time the commercial status of the entire subject is reconsidered by the executives to determine whether the expenditure of the additional money is justified. If not, the study is discontinued.

4 At the conclusion of a research problem, a complete report is made, in which is included the estimated figure on capital expenditure necessary and the savings and other advantages to be gained by the application of the results obtained to regular production so that, if justified, the research work may be turned to profit as soon as possible.

This plan of conducting research work lays continual stress on the *commercial* outcome. At every angle the question is asked, "Is the cost of this particular step justified by the results to be obtained from it?"

Suggested Coöperative Plan

Many companies in different lines are carrying on research work, each on problems in its own line. There are, however, many problems which should be studied but which are not receiving the attention they deserve because they do not present sufficient probability of making a satisfactory monetary return to justify any one company proceeding with the work.

Much research now done by manufacturing companies has to do only with that part of the subject which is of direct interest, frequently the effect of one or more of the variables is not determined, and frequently also, the study is only conducted to obtain a part of the curve. Further, there is a great deal of research work, of great importance to industry, but which is not done because it is seldom that any one company can justify conducting an abstract scientific reseach with the hope that the result of that research can be profitably applied to its business in some way.

True, a great deal of such work is being done by the universities or similar institutions, and some of it by the Bureau of Standards and other departments of the Government. The governmental departments, however, cannot be altogether depended upon because of the difficulty of securing the necessary appropriations. This kind of research work in the universities must necessarily show slow progress because it must be carried on during the spare time of the member of the faculty who is working on it, and it is difficult for a man engaged in university work to have the perspective necessary to obtain the results in the way most suitable for commercial use. Further, the problem selected to be worked upon depends upon the desires of the man who happens to have the opportunity and desire for research work, and is not determined as it should be from a broad viewpoint to insure that the most important subject receives earliest attention.

How much better it would be if a fund could be collected by subscription from manufacturing companies and others interested, and this fund placed under the control of some central body, such as the Research Committee of The American Society of Mechanical Engineers, which would fix a program of research work to be conducted, the place where the work should be done, and the methods to be followed in doing it.

With such a plan, information very necessary to industry would be obtained many years sooner than under the haphazard plan now followed. More complete and scientifically accurate information would be obtained, and the results would be much more widely distributed and made available for industry. As is quite important also, the total cost to industry would be very much less than where many concerns duplicate effort, as is now being done. To accomplish the best results, such a fund should be a continuing one, so that a program could be adopted for several years' work.

The American Society of Heating and Ventilating Engineers has had such a plan in effect for the past two years, with subscriptions amounting to $25,000 per year for five years. The coöperation of the U. S. Bureau of Mines was secured, and the Bureau loaned excellent laboratory facilities in the fuel-testing station at Pittsburgh. This latter is equivalent to approximately $20,000 per year, so that the equivalent of $225,000 is available altogether in this instance. An excellent technical staff is employed and good progress has been made. The work is directed by the Research Bureau of the Heating and Ventilating Society.

With the wide field covered by the A.S.M.E., no difficulty should be experienced in raising a similar fund, ample to carry on an ambitious research program and secure data of inestimable value to industry. Some of this research would be carried on in a laboratory to be financed and controlled by the committee directing this fund, and some of it at universities, the necessary financial assistance being provided from the fund. This would also increase the scope of the research work which the universities could carry on, as the necessary financial support would be easier to secure.

RESEARCH IN LEATHER MANUFACTURE

By Arthur W. Thomas, New York, N. Y.

THE art of leather manufacture is a glaring example of the need for scientific research, and if conditions in some other industries are comparable with those of the tanning industry, it is time that attention is given to publicizing the research which has been done, if only to show the small amount of accurate scientific data upon which these industries are based.

In the average tannery the majority of the operations conducted in transforming rawhide into finished leather are conducted in essentially the same manner chemically as they were centuries ago. Frightful "formulae" similar to "shot-gun prescriptions" of the old-school physicians have been jealously guarded in the tanneries and have been handed down from generation to generation.

The point of view is usually that since good leather was being made in 1000 B.C. or 1776 A.D., why bother about scientific research? This impedance in the leather industry will soon be overcome by competition.

To give an example, the foul practice of bating with dungs is still to be found in many tanneries, though it has been found that artificial bates can be prepared with the necessary proteolytic enzyme in the dungs—and even the value of the presence of pancreatic enzyme is now questioned.

Fundamental advances in the science of leather formation have been made in the last few years, and he who can understand the new chemical thermodynamic theory of Proctor and his students, notably Wilson, can safely discard all his old rule-of-thumb methods and feel sure in advance just what is going to happen in his processes.

Many other examples might be given. Stasny's studies of limings have proved that the old idea of necessity for the presence of ammonia in lime liquors was unfounded, and that the factors which count are regulation of alkalinity and proportions of sulphide.

Studies of the combination of chrome and collagen have prevented the running of tons of chrome into the sewers because of lack of knowledge of the reaction forming the insoluble impurtrescible chrome-collagen compound. And so on.

Instances in which mechanical engineering has improved the efficiency of leather manufacture are numerous.

The designing of extractors and vacuum evaporators has made possible the manufacture of concentrated vegetable extracts permitting quicker tanning and eliminating the expense of freight on barks.

Machinery for unhairing, fleshing and shaving hides have eliminated much hand labor, although there has not as yet been invented a machine which will completely dehair.

Large mechanical rocking systems have improved the liming operation.

Since animals are raised primarily for their meat and wool, tanners are obliged to use a by-product as their raw material, often under great handicaps. Disease in the animal, admittedly fatal in the meat industry, is also a serious factor to the tanner.

The warble fly problem has been acute. This insect deposits its larvae in the hide of the animal, which becomes filled with holes. The only preventive so far is to watch the live cattle and remove the pest by hand.

To summarize, there is a great field in the tanning industry, by the prosecution of scientific research, to eliminate the unnecessary wastes due to lack of knowledge of the reactions and hence waste of time and materials. Further, publication of the knowledge already available will do much to produce a better product, and make it available at a better price, restoring leather to the point at which it can successfully compete with other materials.

RESEARCH PROBLEMS DISCUSSED

THE first paper to be discussed was that by Mr. Wardenburg. The idea that the DuPont Company insisted on the promise of profit before it gave approval to research, was a surprise to M. C. Stuart,[1] and he thought it would be to others. On the other hand, C. E. Lucke[2] thought that this was the most important paper of its kind he had ever heard. Whether it expresses the correct ideal or not, he did not think as important, as the fact that it could be expected that the maximum research would be done by business corporations.

Dr. Lucke thought that one of the most valuable contributions a Research Conference can make is a classification of research. In such a classification the most important kind is that of improving commercial products.

Albert Kingsbury[3] thought that too close a scrutiny of research subjects sometimes hid things which would otherwise come to light. Further, things set forth as objects in research are often not obtained, but on the other hand, by-products sometimes turn up of a value often exceeding the primary object.

L. F. Lyne, Jr.,[4] continued on the line of Mr. Kingsbury's remarks, and added from his personal experience with lubricants.

F. A. Wardenburg, in closing this part of the discussion, said that most firms finding it necessary to earn a maximum return on their capital were not carrying on research. However, he felt that such concerns would be glad to contribute to some coöperative program, carried out under proper auspices and including subjects in which they were interested.

A Familiar Research Discussed

To bring out ideas of value to the conference, the chairman called on Prof. H. F. Moore, of the University of Illinois, well known in connection with the investigation there of fatigue of metals, or, as Professor Moore put it, "progressive failure of metals under continuous stress."

In describing the scope of the problem, Professor Moore characterized it as "involving much indefinite research into first principles, whose outcome could not be seen."

The National Research Council first saw the problem, and secured a large grant of funds to carry on the investigation. The Engineering Experiment Station at Illinois contributed the laboratory apparatus and also Professor Moore's time. One large commercial company found the apparatus and organization could be effectively utilized for certain work it wanted done.

The work therefore represented a measure of coöperation between the National Research Council, the Engineering Foundation which supplied the money, the Experiment Station at Illinois, and one commercial company.

The Research was carried out under a definite agreement, and the University charged a price. An interesting part of the agreement was that the data of the entire investigation should be open at any time to any interested party.

To his mind, this research pointed out the value of coöperative investigation between quite widely different interests. He saw no reason why such an arrangement should not be duplicated elsewhere.

Both Mr. Flinn and Dean C. R. Richards[5] called attention to the fact that though this investigation has been completed, the apparatus is still available to any industries which might want to use it. Dean Richards put it that it would be unfortunate if this laboratory, now brought to a proper degree of efficiency, were disbanded before it had gathered in the knowledge not only of ferrous, but of non-ferrous, metals. Dean Richards called attention to one fundamental condition—that the obligations of the University to the public compel it to own and control the first right of publication. He thought it a great mistake when such institutions keep their results secret.

Dean Richards thought that in the long run the more complete our knowledge of science in its application to industry, the greater the confidence of the people in using the products of industry. So that the idea that research must be kept for a secret use, and to keep competitors from meeting competition, is entirely wrong.

A Small Beginning Develops Into Big Work

Dean Richards also cited the research at Illinois, in connection with the National Warm Air Heating and Ventilating Association, into house-heating furnaces. In the beginning, while the members of the association thought the research would be good, especially good, advertising, they had no conception of the results to be obtained. Now, as the work has gone on for four years, their attitude is entirely changed, and they want it continued until nothing more is to be gotten out of it.

Secrecy of Experiments Undesirable

An interesting sidelight on secrecy was exposed by E. J. Prindle,[6] who said that not only was it an altruistic thing to reveal secrets of research, but it was a dangerous thing not to reveal them from the standpoint of the Patent Law. The law sustains the man who first discloses the discovery, and not the man who first makes it. The object of the Patent Law is to help the man who not only makes an invention, but who discloses it to the world so that it may become public property after a given period of protection to the inventor.

L. F. Lyne, Jr., gave an example of costly duplication of effort resulting from violation of the principle which Mr. Prindle pointed out. One concern had spent $300,000 in developing a certain product and putting it on the market, while another concern located not very far away was carrying on exactly the same investigation.

The product was a lubricant, and apart from the number of commercial concerns there are at least four societies—all represented at the conference—giving their attention to lubricants. As he understood it, one of the purposes of the National Research Council is to bring together such interests as these.

Mr. Flinn replied to Mr. Lyne that such was one of the functions of the Council. He could give good examples of such service in the iron and steel industry, the welding industry and others.

Work of the A.S.H. & V.E. Described

Dean Anderson, research director of the American Society of Heating and Ventilating Engineers, showed how in research starting out for one thing often led to searching for others. Their work at the Bureau of Mines Laboratories in Pittsburgh started out with the goal of finding the relationship between air temperature and humidity and air motion—a thermodynamic problem. Soon it developed into research on some fundamental laws of the cooling powers of vapors. The effort on the human body turned the problem into a physiological one and brought in the Bureau of Health.

Primarily the work of the laboratory has been to take the numerous problems presented by the manufacturers, and from them determine the fundamental relationships.

With regard to publicity, he expected that we were doing things today that the Chinese did two thousand years ago—doing them again because the Chinese left no record of how they were done. With this experience, there is a tendency now for no one to keep from the scientific world anything he may find out.

Advocates a National Laboratory

In calling attention to the amount now spent by the A.S.M.E. annually for research, Dean Anderson asked if more money could not be appropriated. He thought the Society should establish a research laboratory like those at Illinois University or Pittsburgh. He regarded such a plan as the foundation of the Society—not to collect data about the isolated pieces of research going on about the country, but to have a real research laboratory for the general sciences.

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[1] Prof. Mechanical and Marine Engineering, Naval Post-Graduate School, Annapolis, Md. Mem.Am.Soc.M.E.

[2] Consulting Mechanical Engineer, New York, N. Y. Mem.Am.Soc.M.E.

[3] Kingsbury Machine Works, Frankford, Philadelphia, Pa. Mem.Am.Soc.M.E.

[4] Pres. and General Manager, Oil Specialties & Supply Co., New York, N. Y. Assoc-Mem.Am.Soc.M.E.

[5] Dean, College of Engineering, and Director Engineering Experiment Station, University of Illinois, Urbana, Ill. Mem.Am.Soc.M.E.

[6] Patent Attorney, Prindle, Wright and Small, New York, N. Y. Mem.Am.Soc.M.E.

Professor Matthews and Dean P. F. Walker both endorsed the laboratory idea. Dean Walker said that the discussion had taken a turn which had been in his mind for years, especially in connection with oils and lubrication. He happened to be a member of the A.S.T.M. Committee on Lubrication, and seeing the report of the A.S.M.E. Committee on Lubrication on the program, he wondered whether there were any connection between the two organizations.

This was a cue for the presentation of the Report of the Sub-Committee on Lubrication, and Professor Greene therefore called for it.

A.S.M.E. WORK IN LUBRICATION

IN presenting this report, Albert Kingsbury said that it was simply one of progress for the past year. The committee was organized five or six years ago, and at that time, from a general survey of the situation it was decided for the present to deal with the absolute fundamentals of the subject only.

Practically everything we know about lubrication has been evolved in the last forty years, and one problem—that of the conditions existing in the ordinary bearing under normal conditions—had practically monopolized all activity in this line.

The ideal condition in a bearing is one in which the film of lubrication should be of measureable thickness, and should separate the component parts of the bearing so that the frictional resistance is transferred from the metal and becomes entirely fluid friction.

It has been known for a number of years that the ideal condition is subject to treatment by theory, and definite formulas have been evolved so that fairly accurate predictions can be made.

It is well understood that the property of a lubricant maintaining its function is viscosity. Another important property is "oiliness," which for some reason unknown so far seems to be greater in the organic than in the mineral oils.

The work of the committee has been devoted to carrying on experiments on oils under high pressures, up to 44,000 lb. per sq. in., and the results so far justify going to still higher pressures. Having obtained some indication as to what happens at 3000 atmospheres the committee is anxious to find the conditions at 30,000 atmospheres, and hopes to do so later on.

PROGRESS IN STEAM-TABLE RESEARCH DESCRIBED

BY a fortunate coincidence there were brought together at the conference Mr. George A. Orrok, who induced the A.S.M.E. to accept the administration of a fund subscribed by the industries to make a research into the upper limits of the steam tables and establish fundamental constants, Professor Greene, under the auspices of whose Research Committee the technical work was being done, Dr. S. W. Stratton, Director of the Bureau of Standards, which has carried out some of the investigations, and Dr. H. N. Davis, of Harvard University, in whose laboratory another part of the experimental work is being done.

From the information given by these four gentlemen the meeting obtained a very good idea about how this work was being financed and how administered, how far the experimental work had proceeded, and what were some of the difficulties.

Doctor Davis gave a popular conception of what it meant to "try and get something on the Thomson-Joule effect." Then he turned to Dr. Stratton and told the meeting what it meant to "try to get something out of the Bureau of Standards"—how the Bureau would reply to letters and say that "progress was being made," whereas detailed inquiry would reveal that the Bureau had had several of its best men on the job for some time.

Doctor Davis thought that all in all, the probability of completing this fundamental piece of research work was "very hopeful."

A. D. Risteen[1] endorsed Doctor Davis' experiences of the difficulties of doing this kind of work. He also congratulated the Society for having taken it up, characterizing it as a "public scandal" that this one fundamental thing in the whole subject of accurate thermal work had not been done before. A full account of this research has already been published in MECHANICAL ENGINEERING. Mr. Orrok then detailed the progress in collecting the funds.

Mr. Rice, the Secretary, here suggested the organization of a permanent committee to devote itself especially to this particular piece of research, and this was accepted, the Committee to be appointed by the Council of the Society on the recommendation of the Research Committee.

[1] Director Technical Research and Safety Publication Work, Travelers Ins. Co. & Travelers Indemnity Co., Hartford, Conn. Mem.Am.Soc.M.E.

A SESSION ON FUEL ECONOMY

(Continued from page 113)

equipment of certain installations referred to by the author but not mentioned by him. While the conclusions drawn were correct, he said, all the facts should be known.

Edward N. Trump said that he had had the unique experience of buying boilers from the same company for forty years, which had given him an opportunity of seeing whether or not it paid to economize. By replacing at a cost of about one million dollars an equipment of boilers of from 12,000 to 15,000 horsepower with which an efficiency of 70 per cent was obtainable with an equipment capable of 80 per cent efficiency, the cost of the investment was saved in five years.

David Moffat Myers gave some actual figures of savings with the investment costs involved which has come under his observation.

R. L. Beers[20] presented a written discussion of the savings to be made with the use of stokers applied to small hand-fired boilers.

GAS PRODUCER PROBLEMS DISCUSSED

Walter W. Oakley[21] said that the greatest problem in the operation of the producer is labor turnover. Mechanical producers are a help, but even mechanical producers require an attendant. Costs for gasifying a ton of coal in a hand-poked producer are about one dollar, while in a mechanical producer they are about 15 cents these figures being for labor charges. The costs of the mechanical producer can be equaled with hand-poked producers if it is possible to keep trained men on the job.

Earle E. Adams[22] spoke of the use of tar extractors and the returning of the tar to the producer to be gasified. He thought the Fuels Division should give more thought to the use of gas, while J. H. Taussig[23] said he thought the Division should give more attention to the use of fuel for industrial purposes.

Edward N. Trump said that the paper had not considered the recovery of sulphate of ammonia and other products from coal. He had built a plant consuming about 100 tons of coal in which 80 lb. of sulphate of ammonia was obtained per ton of coal.

Jas. H. Matherson[24] presented a written and illustrated discussion on improvements in gas equalizers and soot collectors for gas producers, installed in the tube works of the Reading Iron Co., Reading, Pa. The advantages claimed as a result of these improvements are a saving in fuel of 20 to 25 per cent, an increased product of improved quality, a saving in gas valves, brickwork, labor, machine-shop repairs and cleaning out of soot, more continuous operation of furnaces and more contented workmen.

J. Frank Rogers,[25] in a written discussion, set forth sixteen requirements for a gas producer.

A Correction

In Mr. A. L. De Leeuw's discussion of Mr. Polakov's paper, on page 17 of the January issue, second column, eighth line, the word "demoralization" should have been "democratization". The error was unfortunate, as it was possible to publish only a brief mention of Mr. De Leeuw's comprehensive and meritorious discussion, and quite a misleading conception of his ideas was conveyed.

[20] Engrg. Dept., Under-Feed Stoker Co., Detroit, Mich. Mem.Am.Soc.M.E.

[21] Asst. Engr., Corning Glass Wks., Corning, N. Y. Mem.Am.Soc.M.E.

[22] Sales Engr., The Smith Gas Engrg. Co., Dayton, O. Mem.Am.Soc.M.E.

[23] Engr. of Design, The United Gas Improvement Co., Philadelphia, Pa. Mem.Am.Soc.M.E.

[24] Reading, Pa.

[25] Engr., Gas Producer Dept., The Wellman-Seaver-Morgan Co., Cleveland, O. Mem.Am.Soc.M.E.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

The Flow of Air and Steam in Nozzles

NOTE ON THE FLOW OF AIR AND STEAM IN NOZZLES, Gerald Stoney and Norman Elce. It is now generally recognized that steam when expanded rapidly, as in turbine nozzles, becomes supersaturated provided that the initial superheat is not so high that the steam remains superheated throughout the expansion. Whether any condensation takes place before the nozzle throat is not so definitely known, but some evidence on this point is afforded by the following note on discharge coefficients.

If the theory of supersaturation be correct, the expansion of steam through a nozzle is so rapid that condensation cannot take place down to a pressure below the critical pressure, so that down to the throat the steam expands as a perfect gas. The law of expansion is then:

$$p\,(V-b)^{\gamma} = \text{a constant} \quad \ldots\ldots [1]$$

where $\gamma = 1.3$
p = absolute pressure
V = specific volume
b = co-volume, taken as the specific volume of water at 32 deg. fahr.

The co-volume b is only 1 per cent of the specific volume V at pressure $p = 300$ lb. per sq. in. and neglecting this the maximum theoretical discharge of steam through a nozzle may be shown to be

$$q_{max.} = 0.3155 a_t \sqrt{\frac{p_1}{V_1}} \text{ lb. per sec} \quad \ldots\ldots [2]$$

where
$q_{max.}$ = maximum theoretical discharge, lb. per sec.
a_t = nozzle throat area sq. in.
p_1 = initial pressure, lb. per sq. in.
V_1 = initial volume, cu. ft. per lb.

The effect of the small term b neglected here is only 0.274 per cent of the discharge at a pressure $p_1 = 300$ lb. per sq. in. abs. The value of V_1 to be inserted in Equation [2] is in each case the specific volume of the steam at inlet, whether superheated or wet.

For saturated steam, Equation [2] may be written in the convenient form:

$$Q_{max.} = M_1 a_t p_1 \text{ lb. per hr} \quad \ldots\ldots [3]$$

where:
$Q_{max.}$ = maximum theoretical discharge, lb. per hr.
M_1 = a constant depending upon p_1 and upon the index in the adiabatic equation, which is here taken as 1.3, the value for dry steam.

Rateau (Réchérches experimentales sur l'ecoulement de la vapeur d'eau) measured the discharge of saturated steam through convergent nozzles, and found the empirical equation:

$$Q_{max.} = 3600\ (15.26 - 0.96 \log p_1)\ a_t p_1 \text{ gm. per hr} \quad \ldots\ldots [4]$$

where
a_t = sq. cm.
p_1 = kg. per sq. cm.

In English units this becomes:

$$Q_{max.} = 3.456\ (17.05 - \log p_1)\ a_t p_1 \text{ lb. per hr} \quad \ldots\ldots [5]$$
$$= M_2 a_t p_1 \quad \ldots\ldots [6]$$

where
a_t = sq. in.
p_1 = lb. per sq. in.
M_2 = a constant depending upon p_1.

Table 1 shows values of M_1 for $\gamma = 1.3$ (the index for dry steam) and $\gamma = 1.135$ (the index for saturated steam), and of M_2 for various values of p_1.

If the limit of the supersaturation condition is such that no condensation occurs before the throat, the ratio $\frac{M_2}{M_1(\text{for } \gamma = 1.3)}$ is the coefficient of discharge C_d for saturated steam in Rateau's convergent nozzles, and this should then be of the same order in this case as for any perfect gas, such as air or highly superheated steam, through similar nozzles.

Table 2 shows the comparison of the coefficient $\frac{M_2}{M_1\ (\text{for } \gamma = 1.3)}$ with

1 The coefficient of discharge of air through a convergent nozzle from the experiments of T. B. Morley (Proc. I.Mech.E., January, 1916).

2 The coefficient of discharge of highly superheated steam through a convergent nozzle from the experiments of A. L. Mellanby and W. Kerr (Trans. Inst. Engineers and Shipbuilders of Scotland, December, 1920).

TABLE 1

p_1	300	250	200	150	100	50	14.689	10	5	1
M_1 ($\gamma = 1.3$)	52.12	52.39	52.73	53.16	53.83	55.02	57.25	57.93	59.46	62.34
M_1 ($\gamma = 1.135$)	49.64	49.91	50.22	50.63	51.23	52.41	54.54	55.22	56.64	59.33
M_2	50.37	50.65	50.98	51.42	52.02	53.06	54.90	55.49	56.52	58.93

TABLE 2

Medium	Reference		Initial Pressure, Pounds per Square Inch Absolute. 150	100	75	50	25	10	1
Saturated steam	Rateau	C_d	0.967	0.966	0.965	0.964	0.962	0.958	0.945
Steam at 250 deg. fahr. superheat	Mellanby	C_d	...	...	0.975	...	...	...	...
Air	Morley	C_d	...	...	0.97	0.97	0.97	...	...

It is thus seen that the coefficient of discharge for saturated steam is, according to Rateau's tests, slightly less than that for air and superheated steam, which are about the same. On the other hand, Rateau's nozzles were not all so well shaped as those tested by Mellanby and Morley, so that the evidence, although not quite conclusive, is that there is little or no condensation in the expansion of saturated steam in a nozzle down to the critical pressure ratio. It would be an interesting investigation to determine the coefficients of discharge for steam initially wet, saturated and superheated, and for air, through the same nozzle, and thus determine whether there is any condensation before the throat with wet or saturated steam. So far as the above evidence goes, there is no such condensation and saturated steam acts down to the throat as a perfect gas with an adiabatic index of 1.3. (*Engineering*, vol. 112, no. 2918, Dec. 2, 1921, pp. 750-751, *tA*)

Short Abstracts of the Month

AERONAUTICS (See also Internal-Combustion Engineering)

BRISTOL GAS STARTER FOR AERO ENGINES. Description of a starter made by the British Aeroplane Co. in England for the Jupiter aero engine, but applicable to many other makes. This starter, the Bristol, consists of a small two-stroke, air-cooled, single-cylinder gasoline engine whose crankcase is mounted on to a pumping cylinder. The latter draws a combustible mixture from the carburetor, supplies the power cylinder, and pumps the mixture under pressure to the main-engine cylinders. Interposed between the pumping cylinder and the main-engine cylinder is a

small disk-valve distributor driven at half engine speed from the main engine, which passes the compressed explosive mixture to the main-engine cylinders in the proper sequence. The mixture is admitted on the firing stroke and also on part of the induction stroke. In order to avoid loss of pressure through the open inlet valves on the induction stroke, the port in the distributor which is in communication at this period is controlled by a spring-loaded ball valve arranged to open at a pressure of about 40 lb. The gas cylinder is fitted with a two-cylinder magneto from which one ignition lead is taken to the spark plug of the two-stroke upper cylinder, while a second is taken to the central terminal of the distributor on one of the main-engine magnetos. When the two-stroke engine is started, explosive mixture is supplied to the main-engine cylinders under pressure, and the main engine begins to turn. At the same time gas is admitted to the cylinders so that after one complete revolution of the main engine the entire induction system is filled with gas which is drawn in on the next induction stroke.

If, now, the short-circuit switch between the starter and magneto and the main-engine magneto is opened, the engine will begin to fire and pick up on its own carburetors. The gas-starter throttle supplies both gas and ignition to the main engine for starting, and, in addition to its function as a starter, can be used for driving wireless generators, etc.

It is stated that the Bristol starter has started a Jupiter engine from cold in 17 sec., and when hot in 2 to 3 sec. It has turned over a 500-hp. engine cold at 12 to 15 r.p.m., and has maintained a gas pressure of 140 lb. per sq. in.: it weighs complete 40 lb. The article does not give specific data as to how in actual service the starter is controlled from the aviator's seat. As the normal power of the Jupiter engine is 345 hp., the weight of the starter is only a little in excess of 0.1 lb. per hp. (*Flight*, vol. 13, no. 48/675, Dec. 8, 1921, pp. 802–803, 2 figs., *dA*)

AIR ENGINEERING (See Steam Engineering)

CORROSION

Colloidal Theory of Rust, Dr. Newton Friend. Abstract of a lecture before the Birmingham Metallurgical Society on Recent Progress in the Study of Corrosion. The author is head of the Chemistry Department of the Birmingham (England) Municipal Technical School.

After examining various theories to account for the phenomena attendant upon corrosion, Dr. Friend directed attention to the "colloidal theory" which had been formulated by himself, and which, he said, reasonably accounted for the facts. If moving water was increased to a velocity of eight miles per hour, no corrosion of immersed metal took place. According to the colloidal theory, corrosion of iron in a neutral solution of water was entirely distinct from corrosion in acid. Iron first passed into solution through the presence of electrolytes, gradually developing a solution of ferrous hydroxide, which eventually produced oxidation. The solution, however, could be removed by rapidly flowing water, thus inhibiting corrosion. The same retardation could be effected if the colloid was coagulated either by physical or chemical precipitants.

Particulars were given of various experiments made to test the theory. Solutions containing alcohol reduced rust relatively to the increase in alcohol.

On the question of the effect of temperature on the rate of corrosion, practically nothing was known. But experiments had shown that at 80 deg. cent. iron corrodes nearly ten times as rapidly as at 0 deg. The effect of light was very remarkable. Light was shown to accelerate corrosion very markedly, even after the temperature effects had been removed. Corrosion was clearly affected by barometric variation. The subject was very complex, and the results were not always the same, even when experiments were carried out under what appeared to be exactly identical conditions. The lecturer expressed the hope that further experiments would indicate the bearing of the colloidal theory upon the corrosion of ferrous alloys and non-ferrous metals. (*The Iron and Coal Trades Review*, vol. 103, no. 2805, Dec. 2, 1921, p. 793, *t*)

ENGINEERING MATERIALS (See also Corrosion)

New Etching Mediums for Steel. Dr. A. Fry described in a German periodical *Stahl und Eisen*, Aug. 11, 1921, a new etching method consisting essentially of a strong acid solution of copper chloride over a properly prepared steel.

The new medium reveals in details the strain lines in a low-carbon steel as distinct from the actual crystalline pearlitic or other structure. In other words, it permits locating alterations in the body of steel caused by stress. In this connection mention is made of an experiment recently conducted by a large eastern railroad, the results of which are in good accord with those obtained by the German method. Thin strips of highly polished low-carbon steel were laid on the surface of the rail, over which the locomotive wheel was allowed to press gently. It was found that there resulted in the strips a distinct set of lines entirely different from anything encountered previously. It is now found that these lines bear a close resemblance to the strain lines brought out in one of the pieces of German steel. (Editorial in *Iron Age*, vol. 108, no. 23, Dec. 8, 1921, pp. 1488–1489, *g*)

Plastic Wood. A new material manufactured by a British concern, namely, a collodion preparation made with very fine wood meal, and as supplied ready for use of the consistency of soft putty.

This material will probably be of most interest in connection with patternmaking and molding, for it can be used for ordinary filling and stopping work in wood patterns and for fillets. It adheres firmly to wood and can be applied and smoothed down by the thumb or a tool. It is claimed to be waterproof, to set quite hard, and can be cut with an ordinary tool like wood and turned in the lathe. It can also be finished with sandpaper. It shrinks slightly in drying but the hardened material is not brittle and nails can be driven firmly into it without cracking it. A solvent is also available to soften the material. (*Engineering*, vol. 112, no. 2919, Dec. 9, 1921, p. 785, *d*)

Wire Cables and Weathering. Taking advantage of the rewrapping of the cables of the Williamsburg bridge over the East River at New York City now in progress, Edward A. Byrne, chief engineer of the Department of Plants and Structures of the City, has been carrying on an examination of the condition of four 18⅝-in. cables of the structure. The sections inspected had the interspaces between wires fairly filled with slushing oil supplied when the cables were constructed (1901–1902) and no signs of corrosion were visible, except for a few spots of discoloration on the outer layer of wires. In the main span, rust discoloration on the outer wires was found at a number of places.

On the Manhattan bridge the cable bands have given some trouble from slipping. This defect has been remedied by modification of details of the cable bands. When slipping occurred the wrapping wire covering the cable between the bands became disarranged and the cable wire was exposed, making prompt replacement of the bands necessary. In such replacement the band is set back to its proper position and a short section of the wire wrapping to either side of the band is renewed. Before this is done, however, the cable wires are wedged apart and the interior examined.

Still better conditions have been found in the wire-wrapped cables of the Manhattan and Brooklyn bridges. There the wires which are galvanized have in no cases shown any rust. The condition of the structural steel of the Williamsburg and Manhattan bridges was also examined and found to be surprisingly good. Although repainting has been done at intervals of as much as eight or nine years, no structural parts of either bridge have suffered from rust. Except for thin metal in some railings and floor grills, the steel work of both structures is considered to be in perfect condition. (*Engineering News-Record*, vol. 87, no. 23, Dec. 8, 1921, p. 939, *dg*)

Krupp Rustproof Steels, Fritz Huth. At the technical exhibition in Leipzig were shown some so-called "rustproof" steels made at the Krupp Works. These have been developed as a result of investigations carried out at that establishment during the

years 1909 to 1914 on the corrosion of steel, and belong to the class of chrome-nickel steels.

These steels may be divided into two classses. To the first class belong steels of high mechanical strength, while to the other belong steels characterized by high resistance to corrosion and wear. According to a paper by Dr. B. Strauss (*Krupp Monatsheften*, Aug., 1921) the first class of steel contains from 10 to 15 per cent chromium and from 6 to 10 per cent nickel. The steels of the first class belong to the type of self-hardening steels, while the second, if heated to 1100 or 1200 deg. cent. and slowly cooled down, are machinable and tough. Steels of the first class are magnetic and those of the second non-magnetic. In order to produce these steels a carbon-free chromium must be used. It may be obtained either by the aluminothermic process or produced from chromium refined in an electric furnace. Such chromium is, however, expensive, which makes the corresponding type of steel also quite costly, namely, 12 to 15 times as high as ordinary steel. (*Metall-Technik*, vol. 47, no. 17, Nov. 1, 1921, p. 123, *d*)

TENSILE PROPERTIES OF SOME STRUCTURAL ALLOY STEELS AT HIGH TEMPERATURES, H. J. French. The report gives results of determination of tensile strength proportional limit, elongation, reduction of area and strength at fracture throughout the range 20 to 550 deg. cent. for four steels containing about 0.38 per cent carbon, as follows: (*a*) plain carbon steel; (*b*) 3½ per cent nickel steel; (*c*) 3 per cent nickel, 1 per cent chromium steel; and (*d*) 1 per cent chromium, 0.2 per cent vanadium steel.

Brief reference is made to the type of fractures obtained in testing steels at various temperatures and particular attention is paid to comparison of the tensile properties of these alloys at 550 deg. cent. in the neighborhood of which various parts of converters are subjected to stresses in production of ammonia by the Haber process.

Of the four steels tested in normalized condition it appears that the two alloys containing chromium show greater resistance to weakening by increase in temperature to about 550 deg. cent. than either the plain carbon or 3½ per cent nickel steels, and at this high temperature the chromium-vanadium steel is to be preferred from the standpoint of high tensile strength and limit of proportionality.

The carbon and 3½ per cent nickel steels behave alike with rise in temperature above that of the room, and at about 550 deg. cent. the addition of 3½ per cent of nickel appears to have little or no effect on the tensile properties of the carbon steel. (Abstract of *Technologic Paper of the Bureau of Standards*, No. 205, *e*)

Cutting Fluids

CUTTING FLUIDS, Eugene C. Bingham. Machinists have long recognized lard oil as being wellnigh indispensable in certain cutting operations, whereas for the majority of operations in the machine shop much cheaper oils may be used to advantage. The reasons for the superiority of lard oil have not been clearly understood but they turn out to be closely related to the general theory of lubrication, and with the development of fast-moving machines this theory is of vast economic importance.

Theory. One function of a cutting fluid is to cool the work, and for this purpose water with its high specific heat is suited. But since water tends to rust the machines, alkaline substances are added such as soda or soap.

In difficult cutting operations, the chip is apt to "seize" the tool, causing dulling of the tool, roughness of the work, etc., hence it is inferred that in such cases a good lubricant is required and therefore water is out of place.

The experiments of Tower led many to the erroneous belief that two oils of the same viscosity would have the same lubricating value. Consequently the cheaper mineral oils have been regarded as equivalent in every respect to the fatty oils which they once supplanted. There are certain operations in the machine shop such as the threading of micrometer screws, parting off mild steel, threading and tapping wrought iron, boring gun barrels, in which no mineral oil, regardless of its viscosity, will produce the excellent results obtained with lard or other fixed oils. With lard oil, the surface obtained is smoother, the chip is less serrated and longer and the tool lasts longer; further, the production is increased, there is less heating, and, finally, the machine runs steadier.

It appears that whenever two *clean* surfaces of metal are brought together they tend to seize. Many examples prove that a quite invisible layer of impurity will prevent seizure. The clean metal of the chip moving over the face of the tool under great pressure affords a peculiary difficult problem in lubrication. Lard oil has a much higher *adhesion* for metal than have the pure mineral oils. It is drawn in between the chip and the tool and forms a strong film which prevents the chip from adhering to the tool and forming a "bead." Other oils containing fatty acids, or groups of atoms with "residual affinities," such as sperm oil, caster oil, rape oil, etc., have in large measure the advantage of lard oil.

It seems readily possible to improve mineral oils as cutting fluids and as lubricants by adding liquids of high adhesion such as oleic acid, pine oil and fixed oils. Methods are suggested for the measurement of adhesion. While this paper was in course of preparation, the Deeley friction-testing machine and the Lanchester worm-gear machine were being developed in Great Britain, which demonstrate the superiority of the fixed oils as lubricants and the advantage of adding fatty oils of their acids to mineral oils to be used as lubricants.

Practice. Correspondence with the large machine shops in America with regard to their practice in the use of cutting fluids elicited information worthy of record.

The purposes of cutting fluids are to cool the work, lubricate, lessen wear, insure a good finish with accurate dimensions, wash away chips, and prevent the formation of dust. The materials used may be classified as (*a*) oils, (*b*) air, (*c*) aqueous solutions and water, and (*d*) emulsions.

Oils may be animal oils, fish oils, vegetable oils, mineral oils or compound oils. The edible animal oils are too expensive to use as a lubricant hence only the inferior grades are used for this purpose. Fish oils are objectionable unless deodorized, vegetable oils tend to gum, and mineral oils are low in adhesion and are therefore poor lubricants. Compound oils are largely used, containing a large percentage of mineral oil with a smaller percentage of vegetable or animal oil, or a mixture of both. Air is used merely to remove chips.

Water alone is used to some extent, but on account of the tendency to rust, soda, sodium silicate, sodium resinate or other soap are usually added.

Emulsions have the advantage of cheapness while possessing much better lubricating properties than the aqueous solutions. They are of three types. Mineral oil compounded with neutralized sulphonated oil will form a permanent emulsion when mixed with various proportions of water. Mineral oils are also compounded with an alcoholic solution of soap. A third variant is marketed as a paste, it being a thick soap solution with mineral oil added. The second type is the most desirable and the third the least so.

As to the choice of a cutting fluid for a given operation, the character of the operation performed has more to do with the choice of cutting fluid than the character of the metal. For drilling, reaming, milling, planing and sawing emulsions are generally satisfactory. For tapping and threading and parting off compound oils and lard oil are often resorted to. Compound oils are used with automatic screw-cutting machines.

The material cut is also of importance. There is a general consensus of opinion that soft steel and wrought iron are difficult metals on which to get a good surface without lard or sperm oils. They are called "draggy" metals. Cast iron, on the other hand, being brittle, does not adhere to the tool and no lubricant is required. Contrariwise, on a hard brittle steel, lard oil merely produces a "glaze" and turpentine is used with success.

The formulas of cutting oils used by large and successful users are given.

In the search for the true explanation of the remarkable "oiliness" exhibited by lard oil, the surface tension, specific gravity, and specific heat of several oils were studied by A. W. C. Menzies. The question of fluidity was studied by W. G. Kleinspehn. (Abstract of *Technologic Paper of the Bureau of Standards*, No. 204, *ep*)

FUELS AND FIRING

Powdered-Coal Burners and Dust Filters

BURNING POWDERED COAL IN ARIZONA. Description of the plant of the United Verde Copper Co. at Clarkdale, Ariz., where it has been found that it costs less to burn powdered coal than fuel oil (per B.t.u.). In the dust separators muslin tube filters were used at first. The results obtained in keeping the plant free from dust and preventing dust losses from the main vent were highly satisfactory, but several fires occurred and burned out the muslin filter tubes. After this individual filters were placed over each auxiliary collector. These filters consisted of stacks with baffles and water sprays, the dust caught being washed into a pipe line carrying it back into the main coal-storage plant. This system eliminated fires, but allowed considerable dust to escape into the atmosphere. The losses are not, however, of especially great importance.

The original article gives a complete table of costs of preparing powdered coal for fuel, in which 98 cents is stated to be the operating cost per ton, and from 32 cents to $1.88 (depending on the size of production) the fixed charges.

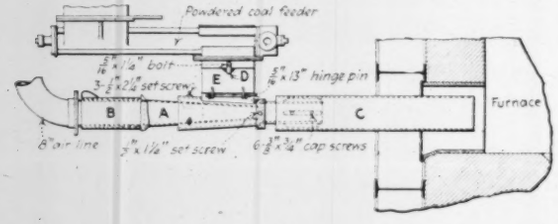

FIG. 1 POWDERED-FUEL BURNER USED AT THE CLARKDALE PLANT, UNITED VERDE COPPER CO., ARIZ.

The powdered-coal burners developed at Clarkdale are shown in Fig. 1. Blower air is delivered through an 8-in. (20.3 cm.) duct to each burner. Coal dust is fed from the 4-in. (10 cm.) screw overhead through the vertical chute E on to the first air nozzle A. The first stage of induced air is drawn in around this nozzle and regulated by means of sleeve B, which slides back and forth over the pipe. The second stage is induced in the burner pipe C after the coal dust has been fed into the air current. The burner pipe contains a fair mixture of powdered fuel and air which is introduced into the furnace through cast-iron burner ports. This mixture acts as a fluid and is under a pressure varying from 3 to 6 oz. per sq. in., (13 to 26 grams per sq. cm.) and contains approximately 85 per cent of the total air necessary for complete combustion. The remainder of the required air is drawn into the furnace through the furnace walls, burner ports, and other openings. (*Electrical World*, vol. 78, no. 23, Dec. 3, 1921, pp. 1121–1123, 1 fig., *dp*)

FOUNDRY

New Side-Blown Bessemer Converter

SIDE-BLOWN BESSEMER CONVERTERS, T. Levoz. Very interesting historical account of the development of the side-blown bessemer converter, with criticism of the various types based largely on the personal experience with them of the writer, who was for many years chief engineer of a steel company in France.

From his many years of experience with converters, the author developed the one shown in Fig. 2, where A is the vertical and B the horizontal section of the converter. In the vertical section 1 shows the bottom of the reverse trunk shape, while 2 is the blast chamber proper V with the tuyere box P. As a matter of fact there are two tuyere boxes, P' and P'', which can be used alternately in order to permit the renewal of the air-drying material, such as pumice stone impregnated with sulphuric acid. S is a tap hole for removing slag as it forms during the period of elimination of silicon. The upper part 3 forms a dome, this particular shape being given to it in order that pieces thrown up from the bath shall collect there and return to the bath. The horizontal section shows the two bearings for tilting the converter. One of the shafts T is hollow to admit the air at the maximum pressure of the blower. A chamber C causes the air to go through a filter F, F', containing dehydrating materials and hence to the tuyeres.

As regards the conditions of operation which would give a maximum of efficiency, it is stated that air from the blower issuing under a pressure of 40 to 50 cm. of mercury goes through the hollow shaft T directly into the air box, from there, on account of the presence of damper C, through the filters F, F', and finally into the tuyeres, where its pressure (around 30 cm. mercury) is so regulated as to avoid an excess of oxidation of iron. This latter is kept particularly low, because of the tangential direction of the tuyeres combined with the truncated shape of the bottom which assures a gyratory movement to the bath of molten pig iron. The dimensions of the bottom of the converter have to be calculated in such a manner that the level of the pig-iron bath should be 5 to 6 cm. (2 to 2.4 in.) above the axis of the tuyeres when the apparatus is in a vertical position and the elimination of silica is going on right. This is essential in order to make certain the discharge of slags through the tap hole S.

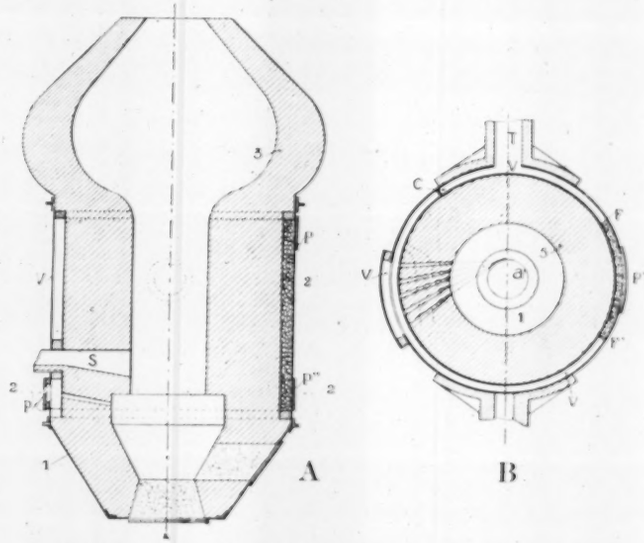

FIG. 2 LEVOZ SIDE-BLOWN BESSEMER CONVERTER

It is claimed that because of the lack of excessive oxidation of iron in decarburization goes on without excessive boiling and such material as may be thrown off by the bath is collected in the dome and returned to the bath again. Other advantages are claimed for this type of converter. (*La Fonderie Moderne*, no. 10, Oct., 1921, pp. 284–290, 3 figs., *dh*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics)

TESTS OF THE 450-HORSEPOWER BRISTOL JUPITER ENGINE. It is a remarkable fact that out of the three aeronautical engines which satisfied the rigid conditions laid down for the British Air Ministry test, one, the Bristol Jupiter, is of the air-cooled radial type. It is also lighter per horsepower than either of the two other makes which passed the test.

The present article, which is an abstract from the Report of the British Air Ministry, gives some data of these tests, which included a 50-hr. endurance test, slow-running test, high-speed test and high-power test. The average oil and gasoline consumptions throughout the tests were: oil, 0.094 pint per hp-hr; gasoline, 0.594 pint per hp-hr.; which are quite remarkable for an air-cooled engine.

On the full throttle test (with a special cam sleeve) the engine developed a maximum brake horsepower of 462 with a gasoline consumption of 0.566 pint per hp-hr.

One of the most interesting tests was the one-hour test with three cylinders cut out. The engine was set to run at 90 per cent

of normal full power, viz., 345 hp. at 1575 r.p.m. The gasoline from one carburetor was cut off, allowing the engine to run on six cylinders only. The engine was run one hour non-stop under these conditions. Naturally there was a certain amount of vibration, but it was not excessive.

At the end of the hour, gasoline was turned on, and the engine picked up to full load at once. The operation was generally satisfactory and there was no oiling up of plugs. The results obtained on six cylinders were as follows:

B.hp.	193
R.p.m.	1250
Oil consumption, pints per hp-hr.	0.0413
Gasoline consumption, pints per hp-hr.	0.685

The official weight of the engine complete but without exhaust pipes and intakes is 729.25 lb. (*Aviation and Aircraft Journal*, vol. 11, no. 24, Dec. 12, 1921, pp. 685–686, 2 figs., *e*)

Rotary-Valve Motor-Car Engine

BOURNONVILLE ROTARY-VALVE ENGINE. The valve consists of two hollow cylinders exactly alike and located end to end, which are driven at one-sixth crankshaft speed. It is located within the cylindrical casting which also forms the cylinder head but is referred to as a valve head. In this valve head the combustion chamber is formed in the casting in such a way that it can be easily machined. Mixture from the carburetor is delivered into the passage at the end of the valve and flows then through the passages of the two halves of the valve to both ends of the valve and then enters a passage called "inlet passage" cored in the valve head. This passage extends the whole length of the valve head and mixture can enter it from both ends. It is in communication successively with the different cylinder ports by pockets in the valve. Each half of the valve has three sets of three such pockets, each set being in line with the cylinder port of one cylinder, and the same pockets in the valve which serve for the inlet also serve for the exhaust.

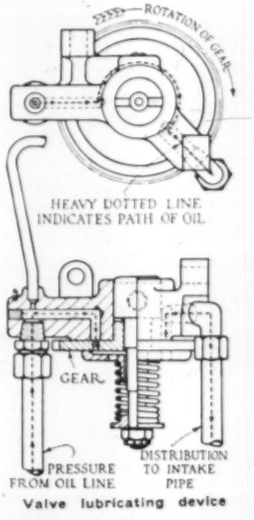

FIG. 3 LUBRICATING DEVICE OF THE BOURNONVILLE ROTARY VALVE

The outstanding advantage claimed for the rotary valve is its absolutely silent operation; further, owing to the absence of top rods and valves at the side of the cylinder block, the accessories can be located close to the cylinders and the engine made quite narrow.

An interesting feature is the special feeding device by which one drop of oil is fed into the inlet pipe between the carburetor and valve head for every twelve revolutions of the crankshaft. This device, Fig. 3, is mounted on the gear case at the upper end of the vertical shaft on the forward end of the engine. It consists essentially of a spur gear which meshes with a spur pinion on the upper end of the vertical shaft. This spur gear is provided with an oil pocket which fills up with oil every time it comes into register with the oil inlet passage (communicating with the regular pressure lubricating system of the engine). After a motion of a little more than half a turn the pocket in the spur gear comes into register with the delivery port communicating with the charge inlet pipe, and the oil is then subject to the suction in the inlet port and is drawn into the charge stream therein, together with which it enters the inside of the rotary valve. Here the oil tends to separate out, owing to its greater inertia than that of the gaseous charge which asserts itself every time there is a change in the direction of motion, and to collect in eight internal circumferential oil grooves, four in each half of the valve. From these grooves radial holes are drilled to the outside of the valve. Through these holes the oil is gradually fed at several points to the bearing surface of the valve. (*Automotive Industries*, vol. 45, no. 22, Dec. 1, 1921, pp. 1065–66, 3 figs., *d*)

Two-Stroke Compound Engine

SILENT SNOW TWO-STROKE-CYCLE ENGINE. This engine, of unconventional design, is of the air-cooled type but has the mixture forced to the cylinders by a slow-speed pump. It is so arranged that a very large piston having a short stroke (31 mm.) pumps the charge into the combustion cylinder, in which is a working piston of the type ordinarily used in two-stroke-cycle engines. The inlet ports in the head of the cylinder are sealed by a speed ring somewhat like a very wide piston ring during the compression and working strokes, but are uncovered when the piston opens the exhaust ports by the fact that this ring contracts and thereby leaves its seat.

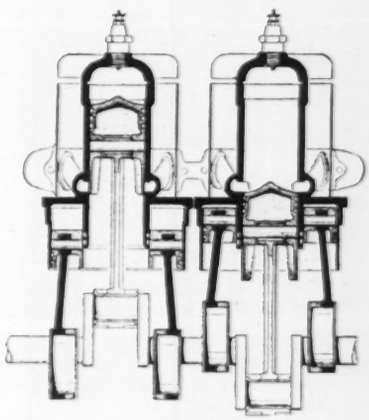

FIG. 4 SILENT SNOW TWO-STROKE-CYCLE ENGINE WITH PUMPS FEEDING MIXTURE TO THE WORKING CYLINDERS

The pump itself is concentric with the working cylinder. It lies within the crankcase. The pump piston is of very large diameter and annular shape so that the spigot of the working cylinder passes through the center, which necessitates an extra set of rings on the working-cylinder spigot.

The working piston is coupled to the crankpin by a connecting rod, while the pump piston is oscillated by eccentrics, straps and short connecting rods, the eccentrics being a part of the crankshaft (Fig. 4). The cycle of operations is as follows:

Immediately after the charge has been fired the working piston is driven down until the exhaust ports are uncovered. As soon as the pressure in the working cylinder falls as the gas is exhausted, the ring valve opens and at the same moment the pump piston forces mixture through the ports in the top of the cylinder, which gives good filling and scavenging. (*The Autocar*, vol. 49, no. 1362, pp. 1129–1130, 3 figs., *d*)

Superinduced-Engine Motor Car

MOTOR CAR WITH SUPERINDUCED ENGINES, R. Krueger. It is claimed that speed-change gears not only constitute an expensive part of motor-car design but that their frequent use is both annoying and entails other disadvantages. Various methods are considered to eliminate them or reduce their use, the chief of which is the employment of the superinduction principle by equipping the motor with some kind of an air pump.

Among the apparatus described are the Roots (British) and Daimler (German) cars.

The Daimler apparatus is shown in Fig. 5. The motor *a* drives through a coupling *b* and a speed-change box *c*, which has, however, only very few speeds. The flywheel of the motor is surrounded by housing *d* and acts as an air compressor, the housing *d* being connected through pipe *f* with the carburetor *g* of the motor. The pipe *f* is provided with valve for cutting in and out the air precompressor.

The car may be operated with the aid of the speed-change drive with the precompressor *d* cut out, in which case the carburetor gets its air from the free atmosphere; or the precompressor may be cut in, in which case a further regulation may be obtained by

varying the pressure of the air supplied from the housing d to the carburetor g.

Furthermore, the speed-change-gear variations may be combined with the operation of the motor on precompressed air, all of this permitting a wide range of conditions of motor operation and power output. (*Der Motorwagen*, vol. 24, no. 30, Oct. 31, 1921, pp. 663-665, 4 figs., *d*)

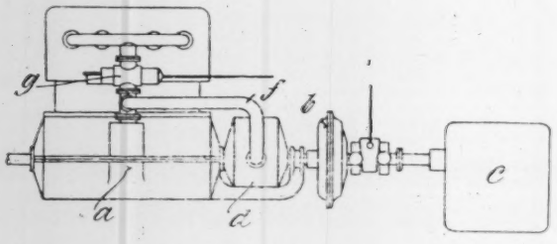

FIG. 5 DAIMLER AUTOMOBILE MOTOR WITH SUPERINDUCTION

MACHINE DESIGN (See also Mechanics)

DOUBLE HELICAL OR HERRINGBONE GEARS, Howard H. Talbot. Discussion of the elements of design, such as tooth strength, friction of tooth surfaces, changes with degrees in spiral angle, tooth pressures, etc. The question of the use of long addenda in the pinion and short addenda in the driving gear to increase the "follow through" is discussed in particular.

As regards the tooth strength, it is recommended as safe to consider a helical tooth approximately one and a half times as strong as a spur tooth of the same tooth section.

The article is not generally suitable for abstracting, notwithstanding its interest.

The general conclusion to which the author arrives is that it is impractical to attempt any standard design of herringbone gears giving interchangeability as we have in the involute spur-gear system. (*The Iron Age*, vol. 108, no. 23 and 24, Dec. 8 and 15, 1921, pp. 1469-1473 and 1531-1533, 17 figs., *tpA*)

SIMPLIFIED APPROXIMATIONS OF CRITICAL SPEEDS, G. Arrowsmith. This article shows a simple approximate method which may be applied to most cases which occur in practice without having to construct bending-moment and deflection diagrams. In the calculation of critical speeds of shafts extreme accuracy is not necessary, as experience has shown that for satisfactory running it is advisable to adopt a rotor of such proportions that the critical speed is removed by from 25 per cent to 35 per cent from the running speed.

Furthermore, a large proportion of cases which occur in practice deals with shafts freely supported at the ends. In such cases the error involved in accepting as a basis of calculation statical deflection as compared with the deflection due to the centrifugal loading is no greater than the error which may occur because of variations in the elastic modulus E of the shaft material.

The writer divides all rotors into two broad classes:

Where the shaft is comparatively flexible throughout its span (class A). For those cases where the ratio d/D (in a stepped shaft, ratio of diameter of smaller section to diameter of large section) is not less than 0.6, the critical speeds can be calculated in terms of weight, diameter, and length of span of shaft from

$$R_k = \frac{K \times 10^6 D^2}{\sqrt{W L^3}}$$

where R_k is critical speed; K is a constant the value of which varies from 1.57 for a centrally loaded shaft to 2.23 for uniform distribution of load; D is the diameter of shaft in inches; W the total weight of shaft between points of support in pounds, and L length of shaft between points of support in inches.

For values of d/D of less than 0.6 the shaft becomes more or less of class B, where the center of portion of shaft is of such dimensions as to render it practically inflexible as compared with the end portion of the shaft. In that case other equations given in the original article can be used, for example, equation $R_k = 187/\sqrt{Y_a + Y_b}$. Where Y_a is the static deflection of the shaft in inches and Y_b the extra deflection due to the flexure of the center portion.

Where d/D is considerably less than 0.6 the flexure of the center portion of shaft is negligible and simplified equations given in the original article may be used.

Illustrations of the applications of the process are given in the original article. (*Engineering*, vol. 112, no. 2917, Nov. 25, 1921, pp. 717-720, 8 figs., *mp*)

Steel Belts

STEEL BANDS FOR POWER-TRANSMITTING AND CONVEYING PURPOSES, Bernard Kruger. In competition with ropes, leather and textile belts, metal bands have made great headway during the past few years in Europe, where it is stated that over 1000 steel-band conveyors are used and close to 1,000,000 hp. is being transmitted by steel bands.

The fundamental rule in the design of these bands or belts is based on the researches of Woehler, who found that a tension constantly varying from zero value to a maximum and frequently applied to a body will cause its destruction, provided the maximum tension is more than half the breaking stress of the material. With this in mind it is always possible to design a belt that will stand up at given stresses by giving it proper dimensions. The belts are made from carefully hardened and tempered carbon steel, rough rolled at red heat and then brought down to standard thickness and width by cold working.

The tensile strength of the finished material is about 95 tons per sq. in. The edges are rounded and so finished that the bands can be safely handled even when running at high velocity. Table 1 gives the approximate weights of belts of various kinds.

TABLE 1 APPROXIMATE WEIGHTS AND DRIVING WIDTHS OF LEATHER BELT, COTTON ROPES, POWER CHAIN, AND STEEL BAND FOR TRANSMITTING 200 HP. AT ABOUT 3000 FT. PER MIN.

System	Weight per foot, lb.	Driving width, in.
Double leather belt	6	24
Five 2-in. ropes	7	15
Three-inch pitch chain	43	7
Steel band	15	8

Owing to the high modulus of elasticity of steel it is very necessary to determine the length of a driving band with considerable accuracy, for a slight extension made necessary by cutting the band too short in the first instance will set up very serious stresses. An ingenious device has accordingly been invented for determining the exact length necessary to obtain a truly correct working tension, allowance being made for the sagging of the band. In this device a measuring band of small breadth and of definite section is mounted on to the pulleys on which the operating band will subsequently be required to run, and the ends fitted into a tension frame. By means of a helical spring and calibrated nut, by the compression of which the arms of the tension frame approach one another, the total tension equaling the desired initial stress per square millimeter in the driving band is read off on a scale provided for the purpose. One of the pulleys around which the band is placed (or also both pulleys in opposite directions) is now slowly rotated so that the friction of the pulley causes a rise in tension in that branch of the band in which the tension apparatus is placed, without, however, the band being driven by the pulley. The tension indicated by the apparatus is noted, the pulley or pulleys are then rotated in the reverse direction, so that the branch under test is slackened to a certain extent; the tension then indicated by the apparatus is again read, and it is ascertained whether the arithmetical mean of the two tensions which has been read corresponds to the desired fundamental tension. The overlaps of the ends of the measuring band are now cut off, and, the tension being released, the remaining length is the correct measurement to which the driving band unstrained must be cut.

In order that metal shall not run to metal and to prevent any possible slip, a friction coating consisting of a layer of canvas, to which are glued thin sheets of cork, is placed over the pulley rim, and to avoid stripping under variable load the pulley rim is first serrated by means of a rough file. A special cement is available for use in very damp situations

In steel-band transmission it is necessary that the pulley face shall be flat; this is owing to the fact that if the pulley is crowned the centers of gravity of the joint clip will be raised slightly from the pulley every time the clip runs on to the latter, thus causing

a blow to be struck which is greater the smaller the pulley diameter and the higher the belt speed. The stress caused by such a blow will be thrown mainly on to the middle of the band and this will cause gradual deterioration of the material at this point and ultimate fracture. As power for power the steel band is only one-third the width of an equivalent leather belt, the use of specially narrow and correspondingly stronger pulleys enables considerable saving in weight to be made, particularly in large diameters, at the same time considerably reducing the cost.

Assuming from a millwright's point of view that the shafts and bearings are properly proportioned and fixed and that the amount of power to be transmitted has already been determined, the necessary calculations are then made for the size and length of the belt to be used. These are based upon carefully worked-out formulas, and as the material is practically static (the maximum and minimum contraction and expansion being only $^1/_{32}$ in. to the yard), the tension necessary for any particular power or width is exactly determined. Thus it will be readily understood that when once the belt has been mounted in the manner previously described it requires no further adjustment.

In many cases, particularly for short conveyors and for certain classes of material, the upper strand of the steel band can slide on a timber support instead of being carried on rollers.

The only variations in length of the band to be taken into consideration are those due to changes in temperature. For short conveyors the tension of the band is adjusted by means of movable bearings of the driven terminal pulley. For conveyors 130 ft. or more in length as well as for conveyors handling warm material, the driven terminal pulley is fitted on a tension frame supplied with counterweights or steel springs to obtain the necessary stretching force.

Various other practical points are discussed, among them applications of the conveyor with steel bands not hitherto considered possible. (*Journal of the Western Society of Engineers*, vol. 26, no. 12, Dec. 1921, pp. 428–432. In this connection attention is called to the paper and experimental investigation of steel belting by F. G. Hampton, C. F. Leh and W. E. Helmick, MECHANICAL ENGINEERING, vol. 42, no. 7, July, 1920, pp. 369–378, 13 figs., to which a short bibliography on the subject is appended)

MACHINE SHOP (See Engineering Materials)

MECHANICS

Simplified Calculation of Rigid Frames

A NEW PROCESS DEVISED BY H. BRONNECK FOR CALCULATING RIGID FRAMES, Professor Marx. An abstract of a chapter from a book by H. Bronneck which has just been published in Berlin, the interest of which lies in the fact that a method is provided for computing the most complicated frame shapes directly and without the use of tables.

Bronneck starts from the fundamental equations laid down in the works of Mueller-Breslau and Moersch. The case of a simple rectangular double-articulated frame may be used to illustrate the process. For this case the shear may be computed from the following equation:

$$x = \frac{\frac{J_c}{J_0}\int_0^h M_0\, y\, dy + \frac{J_c}{J_1}\cdot h \int_0^l M_1 \cdot dx + \frac{J_c}{J_0}\int_0^h M_2\, y\, dy}{\frac{J_c}{J_0}\cdot\frac{2}{3}h^2 + \frac{J_c}{J_1}\cdot l \cdot h^2 \frac{J_c}{F_1}\cdot l}$$

Here M_0, M_1 and M_2 are the bending moments at points 0, 1 and 2 (Fig. 6) induced by external load with the frame statically determined in some manner: J_0 and J_1 are respectively the moments of inertia of the rods and traverses, while J_c is any moment of inertia whatsoever. If, now, to every part dy of the rods be added elastic weight $\frac{J_c}{J_0}\cdot dy$, the first two members in the numerator of the above equation become nothing else but the moments of inertia of the entire frame refer to axis A-B denoted henceforth as T_a. The member $\frac{J_c}{F_1}\cdot l$ is produced by the action of the longitudinal forces

The expression $\frac{J_c}{J_0}\int_0^h M_0 \cdot y \cdot dy = \int_0^h M_0 \left(\frac{J_c}{J_0}\cdot dy\right) y$ represents the static moment of the surface of moments located over the rod AC referring to the AB and hence

$$\int_0^h M_0 \left(\frac{J_c}{J_0}\cdot dy\right)\cdot y = \left(\frac{J_c}{J_0}\cdot f_0\right)\cdot y_{s0}$$

Here f_0 is the area of the surface of moments and y_{s0} the distance of the center of gravity of the surface from AB. The two other expressions in the numerator of X may be determined

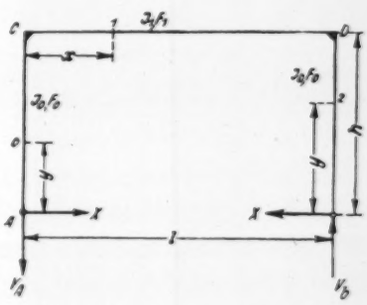

FIG. 6 DIAGRAM OF FORCES ACTING ON A DOUBLE-ARTICULATED FRAME

in a similar manner. If, now, we denote the sum of all these expressions by S_a we obtain for the shear on the frame the very simple expression:

$$X = \frac{S_a}{T_a \frac{T_c}{F_a}\cdot l}$$

By means of this formula the shear may be computed for all possible cases of loading, and the influence of heat variations can be very well taken into consideration in this formula which applies to all cases of double-articulated frames, no matter what their shape may be.

From this Bronneck proceeds to the determination of an equation for the influence lines for S_a for various frame shapes and types of loading.

Such equations for the influence lines can be derived now by means individual for each frame shape. Bronneck has, however, succeeded in deriving an equation of the third degree for computing this statically undetermined magnitude, this equation being $y = a + bx + cx^2 + dx^3$. Here a, b, c and d are constants which depend only on the shape and dimensions of the frame, while x is the variable distance of the single load (1) from a predetermined origin of coördinates. The equation permits, therefore, of immediate numerical computation. (*Dinglers Polytechnisches Journal*, vol. 336, no. 21, Oct. 22, 1921, pp. 301–302, 2 figs. *mA*)

THE EXPONENTIAL METHOD IN THE ANALYSIS OF THE BALANCE OF RECIPROCATING MASSES, P. Cormack. (A mathematical article not suitable for abstracting.) A method is developed from the usual formula for inertia resistance of a reciprocating piston mass expressed by a rapidly convergent series. The author converts this series into an exponential series which is made the basis for his calculation. This calculation is applied to such cases as that of seven-crank engines, offset cylinder engines, radial engines and rotating-cylinder engines; and, among other things, shows that the angular accelerations of the connecting rods are identical in the radial and rotary types. (*Engineering*, vol. 112, no. 2919, Dec. 9, 1921, pp. 778–780, 1 fig., *m*)

MARINE ENGINEERING (See Steam Engineering)

MOTOR-CAR ENGINEERING (See also Internal-Combustion Engineering)

Maybach Powerplus-Cylinder Gearless Car. During the war aeroplane engines were developed working on the so-called "powerplus" idea, that is, the cylinders were made considerably larger than corresponded to the dimensions of the driving parts. The powerplus-cylinder aeroplane engine was intended to work at part throttle on the ground and at full throttle at high elevations, thus developing practically the same power at varying altitudes. The same principle with slight changes has been applied in the new Maybach engine. This engine is fitted with six cylinders 95 mm. (3.75 in.) in diameter by 135 mm. (5.32 in.) stroke. At 900 revolutions it develops 36 hp. and at 2200 revolutions, that is, with full throttle open, 72 hp., this power output being so great as to make speed-change gear unnecessary, except on unusually heavy grades. For use on exceptionally heavy inclines a reducing gear is connected between the engine and the driving shaft. The drive backward is achieved by means of an electric starter, no reversing gear being used.

In this connection the statement is made that the Daimler Motor Co. has provided an arrangement for temporarily increasing the torque by 50 to 100 per cent in their new car. Steel-cylinder engines are used and the device presumably consists in an arrangement for increasing the pressure of the charge drawn into the cylinder, but nothing has been divulged as to its details. (*Engineering Progress*, vol. 7, no. 11, Nov., 1921, pp. 242–243, 1 fig., *d*.—The abstract refers to part of an article entitled The German Automobile Exhibition 1921, pp. 241–246, 9 figs.)

POWER-PLANT ENGINEERING (See also Steam Engineering)

Temperatures and Gas Velocities in Boiler Settings, A. W. Binns and C. E. Joos. Results of tests on a 1000-hp. Stirling boiler with a temperature chart taken by a recording Brown pyrometer. The results are given in tables and curves. (*Power Plant Engineering*, vol. 25, no. 23, Dec. 1, 1921, pp. 1138–1139, 3 figs., *l*)

South Meadow Plant of the Hartford, (Conn.) Electric Light Company. The plant is laid out so as to give an ultimate capacity of 130,000 kw. in five units, with enough ground available to extend this rating to 260,000 kw. The design of the plant is such as to make it readily adaptable to superpower service and has been controlled by the idea of providing twofold service—local and regional.

One of the many interesting features of the plant is the provision of a room for auxiliary and combustion-control equipment, with indicating and recording instruments for measuring pressures, temperatures, steam flow, gas analysis and power output. By this arrangement one man is in a position to maintain proper conditions throughout the plant at all times.

Several other features such as methods of fuel handling, boiler rooms, and the somewhat unusual system of piping, are described in the original article. (*Electrical World*, vol. 78, no. 24, Dec. 10, 1921, pp. 1163–1166, *d*)

RAILROAD ENGINEERING

The "Meteor" Track Torpedo. A new type of track torpedo officially adopted on all lines of the Canadian Pacific Railway. It appeals to all three senses, namely, hearing, seeing and smelling, and on detonation produces not only a loud report but simultaneously a brilliant flash and pungent smell. It is called "meteor" and is fastened to the tracks by means of two spring rail clips made of tempered steel or spring brass. In this way a firm gripping of the rail head is assured and at the same time a prompt application of the torpedo is made possible.

It is completely waterproof, will stand any atmospheric conditions of heat, moisture and frost. It has been subjected to one hundred hours' immersion, and one hour in moist steam at 120 deg. fahr., without deterioration, and has been used where the temperature was many degrees below zero with complete success. Special tests have been carried out to ascertain its holding power when placed in position on the rail, and for flying particles likely to cause injury to bystanders. These have all been carried out with satisfactory results. (*Canadian Machinery*, vol. 26, no. 22, Dec. 1, 1921, p. 51, *d*)

SPECIAL PROCESSES

Rotary-Type Gas Filter

Rotary Filter Process of Cleaning Gases and Vapors. A description of a process intended to be used for removing dust, tar, oil and similar impurities from gases and vapors developed by Freytag-Metzler and tested by E. Stach and Doctor Alexi. The principle of this device is illustrated in Fig. 7 and is based on a continuous renewal of the filter material placed in a slowly rotating filter casing surrounding coaxially a high-speed fan wheel. The filter casing consists of a wrought-iron hollow ring of rectangular cross-section divided into several chambers by intervening walls and rolling on bearings in the lateral covers of the general housing. Between the fan wheel and the filter casing there is a clearance of predetermined width. The material used for filling the filter chambers depends on the impurities that have to be handled.

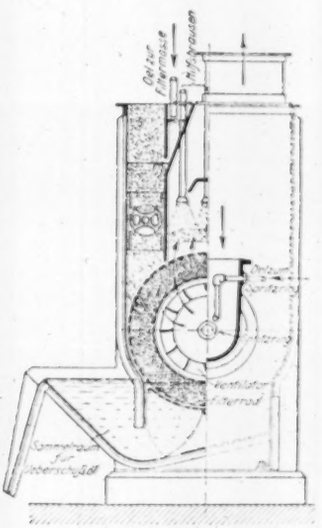

Fig. 7 Freytag-Metzler Gas Filter

(*Oel zur Filtermasse* = oil flow to filter mass; *Hilfsbrausen* = Auxiliary sprinkler; *Oel zum Spritzring* = oil flow to spray ring; *Spritzring* = spray ring; *Ventilator* = fan; *Filterrad* = filter wheel; *Sammelraum fuer Ueberschussoel* = sump for oil overflow)

Thus, for example, for cleaning gases from blast furnaces, copper, zinc and tin smelting furnaces and ceramic kilns, water is used as the cooling and washing liquid, while the filter body is made up of metal, fiber and steel shavings. A small amount of water is sprayed into the fan wheel, while a generous spray is provided from on top. The atomization of water in the fan wheel and its mixing with the gas assists the filter action materially. In order to prevent the filter mass from getting stuffed up by the clinkering of the impurities, which is particularly likely to happen with blast-furnace and cement-kiln gas, the ring constituting the filter housing is placed well away from the fan wheel and the water spray comes between the filter proper and the fan wheel.

The rotary filter can be used for taking oil out of steam and also has an absorption device. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 49, Dec. 3, 1921, pp. 1265–1267, 7 figs., *d*)

STEAM ENGINEERING

Low-Pressure-Turbine Blade Failures in Destroyers, Lt-Com. D. F. Ducey, U. S. N. The investigation was undertaken to determine the causes of certain failures of low-pressure-turbine blading which occurred in the late summer of 1919 on vessels built during the war. From this investigation the following facts were established: Seventeen of the failures occurred in the port low-pressure turbines and five in the starboard low-pressure turbines. The reason for the greater number of failures in the port turbine has not been established and is a subject for further investigation. A theory involving vibration and the greater length of the port lineshafting has been advanced, but this can remain an open problem for the present.

The primary failure, as far as could be ascertained, involved but one or two blades in a single stage. In instances from one to fifteen blades in a single stage were found stripped, but indications were that the failing of one or two blades was the cause of the others going. In no case was there any indication of a general failing of

the blades, the damage usually being confined to the blades being held by a single section of shrouding.

Practically all of the blades ruptured across the root section, although in certain instances where there was a tearing action by the shroud band and loose blades, the rupture occurred higher up on the blade.

In only one instance, that of the 280, did serious vibration exist previous to the blades failing.

Sometimes, when the failure occurred in the earlier stages, the ruptured blade or blades, in going through the following stages, tore blades out of these stages; in other instances the ruptured blade or blades went through as many as three stages and the intervening diaphragm nozzles, without tearing loose other blades. It would be expected that in such cases one would find the blades in the stages intervening between the stripped section and exhaust space badly chewed up, but such was not always the case. The "chewing-up" was usually of minor importance and in one case but five or six blades per stage were involved. As a rule the diaphragm nozzles were easily straightened and but one case of extensive renewals being necessary can be recalled. Incidentally this speaks well for the ruggedness of the turbine design.

Certain imperfections of manufacturing have been discovered, but neither defective material nor excessively bad workmanship has been found to be present.

The material was tested in various ways and chemical analyses and a metallurgical investigation made.

The tests have served to give evidence of the possibility of inducting brittleness in the chrome-nickel steel used for the blading. Furthermore, the design of the type of turbine blade used is such that a sudden change of section occurs between the root and the blade body. This section is the one of maximum bending moment and the maximum stress under bending would be considerably greater even than the theoretical stress. In tests, some of the specimens broke badly or showed cracks.

The general conclusion arrived at, therefore, is that the cause of trouble lay largely in the design of the turbine blade, which was such as to be very poorly fitted for undergoing plastic deformation when bent, without the formation of cracks at the junction of root and blade. This is particularly so, as in some cases there was a tendency to brittleness in the material due to improper microstructure or other causes.

A number of practical recommendations are made. (*Journal of the American Society of Naval Engineers*, vol. 33, no. 3, Aug., 1921, pp. 512–540, numerous illustrations, *deA*)

TESTING AND MEASUREMENTS (See Engineering Materials)

TRANSPORTATION

SYSTEM OF HANDLING L. C. L. FREIGHT IN ST. LOUIS, MO. In St. Louis the Columbia Terminals Co. handles practically all of the less-than-carload freight lots interchanged between the western lines terminating in St. Louis and the eastern lines with depots in East St. Louis, Ill., across the Mississippi River. It also carries to its own warehouses on either side of the river shipments that arrive over different lines for St. Louis or East St. Louis points. From there the consignee can gather in at the same time all of the articles that may have been shipped from a dozen different points and over a dozen different railroads.

The Columbia Terminals Co. which does this work is paid not by the shipper or consignee but by the railroads themselves, who, by the way, make no additional charge for this service. They are enabled to do this because of the fact that it costs them less to handle this kind of freight by truck than by rail. The Columbia Terminals Co. handles only L. C. L. freight, the transfer of carload shipments from eastern to western lines and for local deliveries being in the hands of the Terminal Railroad Association. All the work of hauling is done by 170 horse-drawn vehicles, 75 motor trucks and 35 tractors drawing 150 Lapeer steam trailers.

It is claimed that through its use of trucks and trailers the company handles freight in from 24 to 72 hours less time than it takes to do so in most of the other great gateways of the United States.

The company has a tariff on the same principle as the railroads but no contract with the roads. (*The Commercial Vehicle*, vol. 25, no. 10, Dec. 15, 1921, p. 7–11, 9 figs., *dA*)

VARIA

THE OPEN PRICE ASSOCIATION DECISION OF THE U. S. SUPREME COURT. The American Hardwood Manufacturers Association for some time has maintained a statistical service to its members by which they have been informed of prices at which sales were closed and of impending changes in prices. The U. S. Supreme Court has declared this practice illegal and the dicision has already attracted considerable attention in trade circles. The *Iron Age* (vol. 108 no. 25, Dec. 22, 1921, pp. 1612–1613), believes that this decision will have far reaching effects on all business organizations which seek directly or indirectly to stabilize prices. On the other hand, however, it considers it improbable that the decision will render it impossible for industrial groups to study their respective economic problems.

The *Engineering News-Record* goes into the subject far more extensively but does not believe that the decision in the Hardwood Manufacturers' case finally determines the scope of activities of open-price associations. It considers it final only as to one activity viz., advising on future action.

From the decision in this case it does not appear that mere exchange of information regarding production, stocks and shipments, as well as prices on closed transactions is illegal; support for this opinion is found in the decision of the U. S. District Court of the Northern District of Illinois in the case of the linseed-oil crushers. The Hardwood Manufacturers, however, have gone a step too far.

Passing, however, from the consideration of purely legal aspects of the case, the *Engineering News-Record* expresses the belief that while exchange of information upon closed transactions confined strictly to the membership of an association may be lawful, it is not good policy, as the public, kept in ignorance of these practices but keenly realizing the power that such an exchange gives trade associations, becomes suspicious. The only way to establish confidence in such exchange of information is to follow the practices of stock exchanges and make this information available not only to the sellers, but also to the buyers.

As an instance of the displeasure caused by lack of frankness in giving out price information, the *Engineering News-Record* cites the cement industry. Notwithstanding the many efforts of that journal to obtain from the cement associations statistics on production (not prices), this could not be brought about. The feeling among consumers of cement is so strong in this regard that an influential group of consumers discussed means by which an open cement exchange could be established, in the direction in which public pleasure may be asserted in industries which are mistrusted. (*Engineering News-Record*, vol. 87, no. 26, December 29, 1921, pp. 1046–1047)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

The report (Great Britain) made by Lord Newton's Committee on Smoke and Noxious Vapor Abatement emphasizes the fact that smoke pollution is mainly due to the indiscriminate and wasteful use of raw coal for all purposes, and that this pollution can only be overcome by the government and municipalities taking joint legislative action. Among the recommendations of the Committee is one to the effect that the Ministry of Health should be given power to deal with local authorities who fail to administer the law with regard to smoke emission.

The situation with respect to the domestic fuel problem is recognized and control recommended over the heating arrangements in such new buildings as hotels, clubs, and offices. (*Cp. The Electrician*, vol. 87, no. 2276, Dec. 30, 1921, pp. 806–807.)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Gases in Metals

A WIDE field for research of great practical value is the acquiring of exact knowledge of the gas content of metals. Aside from the more or less familiar relation of gases to the deoxidation of steel and the production of sound ingots and castings, many operations in the refining, working, and treating of metals are vitally effected by the presence of various gases.

Many of the inherent differences in quality of steels made by different processes are generally attributed to the amounts and compositions of the gases with which the metal is in contact when in the molten state in a converter, open-hearth or electric furnace, or in a crucible. It is reported that steel converters operating in a vacuum have recently been successfully used on a commercial scale in England to produce cutlery steel of unusually fine quality. The presence and nature of occluded gas in cast iron has been said to be closely connected with two of its important characteristics, namely, the graphitization of cast iron and the growth of gray cast iron.

Of no less importance are dissolved or occluded gases in non-ferrous metals. For example, the fire refining of copper is wholly a matter of intentionally dissolving a gas (oxygen) in crude copper and then removing nearly but not quite all of this same gas. If the final step of this refining is carried only a minute or two longer than necessary resulting in the complete removal of oxygen, the whole furnace charge must be entirely reworked as if it were a fresh charge of crude copper.

In the working and fabrication of copper, gases also play a part. Operations involving the cleansing of steel or iron by pickling in acids must be followed by treatments designed to remove the hydrogen taken up from the metals by the gases. If not removed this occluded gas will render the metal too brittle to work or will give trouble in subsequent operations when the metal is exposed to heat, as, for instance, causing blisters in enamel. Occluded gases have also been shown to have a marked effect on the electrical conductivity of metals, their magnetic properties, their consistency in dimensions, as well as their mechanical properties.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Automotive Vehicles and Equipment A1-22. Method of Measuring Temperature at Different Points in the Body of an Automobile Tire. Mr. A. O. Ashman in a 14-page pamphlet describes a simple method of using thermocouples to explore the temperature conditions in rubber tires. A copper-constantan thermocouple is employed in conjunction with a potentiometer. Address the New Jersey Zinc Company, 160 Front St., New York.

Fire Prevention A1-22. "Sheetrock." A series of exhaustive tests on this material which may be used for interior wall, ceiling and partition finish have been conducted by the Underwriters' Laboratories and are published by them in a 97-page pamphlet. "Sheetrock" is of the single-cored wall-board type and paper-covered fibered gypsum-plaster pattern. It consists of a layer of fibered hydrated gypsum reinforced by a sheet of heavy tough sized paper securely bonded to the surface on each side. The surfaces on both sides are smooth and true and light gray in color. Great strength combined with toughness as well as heat insulation and fire-resisting qualities are the principal claims for this building material. Address Underwriters' Laboratories, Chicago, Ill.

Fuels, Gas, Tar and Coke A4-22. Coal Carbonization. Present Status of Coal Carbonization at Low Temperatures is the title of Report 2292 to the Bureau of Mines by Joseph D. Davis. The paper was read at the meeting of the American Gas Association on Nov. 9, 1921. The conclusions of the report which gives the meaning of low-temperature carbonization, amount and character of products, uses of products, suitable coals, principles, apparatus and processes are as follows:

"Although increased interest has been manifested in low-temperature carbonization during the past year, progress toward commercial development has been slow. This is probably due in part to market conditions and in part to difficulties experienced by builders in perfecting their apparatus mechanically.

"In order that a low-temperature industry may be firmly established, it is necessary that the popular prejudice against soft coke be overcome, and it will take time to accomplish this.

"It does not appear that low-temperature methods are destined soon to occupy an important place in the gas industry in so far as gas for city supply is concerned. They may, however, be used to advantage in the production of industrial gas.

Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Machine Design A1-22. Bearings in Bronze Bushings. As a result of a research carried on by the Engineering Department of the American Bronze Corporation, data sheets have been developed which contain considerable information of value under the headings, Running Clearances, Permissible Angular Deflection for Journals in Plain Bearings, Relation of Rubbing Speed to R.P.M. Allowances for Press Fits, and A Meritorious Design of Water Pump for Automotive Engines. These data sheets are numbered 107, 108, 109, 110, 111 and 112. Address American Bronze Corporation, Berwyn, Pa.

Mechanics A1-22. Fatigue of Metals. The results of the past three years' investigations of Profs. H. F. Moore and J. B. Kommers on the Fatigue of Metals have just been published as Bulletin No. 124 of the Engineering Experiment Station of the University of Illinois. This bulletin consists of 185 pages and reports in full the method of procedure of experimenters, results obtained and the conclusions which they have drawn. A summary of their conclusions is as follows:

1 For the metals tested under reversed stress there was observed a well-defined critical stress at which the relation between unit stress and the number of reversals necessary to cause failure changed markedly. Below this critical stress the metals withstood 100,000,000 reversals of stress, and, so far as can be predicted from test results, would have withstood an indefinite number of reversals. The name endurance limit has been given to this critical stress.

2 In the reconnaissance tests made in the field of ferrrous metals no simple relation was found between the endurance limit and the "elastic limit," however determined. The ultimate tensile strength seemed to be a better index of the endurance limit under reversed stress than was the elastic limit. The Brinell hardness test seemed to furnish a still better index of the endurance limit The reason why the Brinell test, and, to a less degree, the ultimate tensile strength, seem to be better indices of the endurance limit than the elastic limit is not clear, and this result should be regarded as tentative. Elastic limits determined from compression tests and torsion tests gave no better index than did those from tension tests.

3 The single-blow impact tests (Charpy tests) and the repeated-impact tests did not furnish a reliable index for the endurance limit under reversed stress of the ferrous metals tested.

4 Accelerated or short-time tests of metals under repeated stress, using high stresses and consequent small numbers of repetitions to cause failure, are not reliable as indices of the ability of metal to withstand millions of repetitions of low stress.

5 The endurance limit for the ferrous metals tested could be predicted with a good degree of accuracy by the measurement of rise of temperature under reversed stress applied for a few minutes. This relation is explicable in view of the intercrystalline and intracrystalline slippage under repeated stress shown by the microscope. It is believed that this test, which is a development of a test proposed by Mr. C. E. Stromeyer, can be developed into a reliable commercial test of ferrous metals under repeated stress. Its applicability to non-ferrous metals has not been investigated.

6 Abrupt changes of outline of specimens subjected to repeated stress greatly lowered their resistance. Cracks, nicks, and grooves caused in machine parts by wear, by accidental blows, by accidental heavy overload, or by improper heat treatment may cause such abrupt change of outline. Shoulders with short-radius fillets are a marked source of weakness.

7 Poor surface finish on specimens subjected to reversed stress was found to be a source of weakness. This weakness may be explained by the formation of cracks due to localized stress at the bottom of scratches or tool marks.

8 Stress above the endurance limits, due to either a heavy overload applied a few times or a light overload applied some thousands of times, was found to reduce somewhat the endurance limit of two ferrous metals tested.

9 In none of the ferrous metals tested did the endurance limit under completely reversed stress fall below 36 per cent of the ultimate tensile

strength; for only one metal did it fall 40 per cent, while for several metals it was more than 50 per cent. However, these metals were to a high degree free from inclusions or other internal defects; the specimens had no abrupt changes of outline, and had a good surface finish.

10 It is well known that subjecting steel to a stress beyond the yield point raises the static elastic tensile strength to a marked degree. The effect is less marked on the endurance limit, although some increase was observed for 0.18 carbon steel with the surface polished after being stretched well beyond the yield point. Annealing of commercial cold-drawn screw stock was found to lower its endurance limit somewhat less than it did its static strength.

11 The test results herein reported indicate the effectiveness of proper heat treatment in raising the endurance limit of the ferrous metals tested. Here again it should be noted that an increase in static elastic strength due to heat treatment is not a reliable index of increase of endurance limit under reversed stress.

12 The phenomenon known as "fatigue" of metals under repeated stress might better be called the "progressive failure" of metals. The most probable explanation seems to be that such failure is a progressive spread of microscopic fractures. A nucleus for damage may be a very small area of high, localized stress, due to a groove, a scratch, or a crack; in other cases failure may be due to internal inclusions or irregularities of structure; it may be due to internal stress remaining after heat treatment; it may be due to a grain or group of grains unfavorably placed to resist stress; or failure may begin in the weaker grains of a metal whose structure consists of two or more kinds of grains; or it may, or course, begin in any portion of the metal which, by accidental overload or otherwise, is stressed to the yield point. Address Engineering Experiment Station, The University of Illinois, Urbana, Ill.

Metallurgy and Metallography A1-22. ZIRCONIUM. Bulletin 186 of the Bureau of Mines gives reports of investigations on zirconium with reference to the metal and oxide by J. W. Marden and M. N. Rich with historical review and bibliography. The Bulletin covers 152 pages and contains numerous drawings and tables. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Paints, Varnishes and Resins A1-22. WATER-RESISTING SPAR VARNISH. Circular 103 of the Bureau of Standards is devoted to specifications for water-resisting spar varnish. These specifications were prepared under the auspices of the Bureau of Standards by the U. S. Interdepartmental Committee on Paint Specification Standardization, which consists of representatives of all the Governmental Departments, the U. S. Shipping Board, and the Educational Bureau of the Paint Manufacturers' Association of the United States. The specification gives the general requirements and detailed methods of sampling and testing as well as the basis for purchase. Address Superintendent of Documents, Washington, D. C.

Paints, Varnishes and Resins A2-22. INTERIOR VARNISH. The Bureau of Standards has recently prepared Circular No. 117 which consists of specifications for interior varnish. This specification was prepared by the same Committee mentioned above and gives the general requirements and detailed methods for sampling and testing of interior varnish as a basis for purchase. Address Superintendent of Documents, Washington, D. C.

Photography A1-22. BATHS FOR COLOR SENSITIVE PHOTOGRAPHIC PLATES. An interesting paper on color sensitive plates and methods of sensitizing by bathing has been prepared by the Bureau of Standards and issued as Scientific Paper No. 422. Directions are given for sensitizing plates and film, and the relative advantages of various sensitizers are considered. The various brands of orthochromatic plates which are found to be especially satisfactory, are mentioned, and it is noted that washing commercial panchromatic plates had a favorable action on the color sensitiveness. Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Properties of Engineering Materials A7-21. WASTE SLATE AS FILLER. Report 2283 of the Bureau of Mines discusses the use of waste slate as a filler for various materials. Report 2230 discussed the use of slate dust in asphalt road mixtures. The present report discusses the use as a filler for mechanical rubber goods such as disks, sheet packings, molded heels and soles, hard-rubber battery jars, carriage tires, garden hose, clutch facings and similar products. Slate flour was used successfully as a substitute for whiting, clay, barytes and aluminum flakes. With this filler the rubber would not stand repeated stretchings so readily. It has been found that it may be used as a filler for oilcloth, floor coverings and window-shade materials. It has been used as filler for plaster roofing and flooring. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Protective Devices and Methods A1-22. GAS MASKS FOR GASES MET IN FIGHTING FIRES. As a result of the war the gas mask, which uses a chemical filter for removing poisonous gases and fumes from air, has been developed to a high state of perfection. The mask used by the United States Army is capable of giving complete protection against all the deadly gases that have been met on the battle field, but it does not protect against all the gases or atmosphere encountered in mines and in the industries and in fire fighting. A very thorough study of the construction of the various types of gas masks for use in fighting fires has been made by Arno C. Fieldner, Sidney H. Katz and Selwyne P. Kinney. The results of their investigation are recorded in Technical Paper 248 of the Bureau of Mines. Address Bureau of Mines, Washington, H. Foster Bain, Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Foundry Equipment, Materials and Methods B1-22. MOLDING SAND. Hundreds of thousands of tons of molding and core sands are used annually in the iron, steel and non-ferrous foundries of America. A little of it is re-used; much more might be. Sands are not always correctly selected for specific purposes. Mixing and other treatment can secure improvement. In what ways can foundry practise as to sands be bettered? What economies can be realized, not only in reduced expenditure for sand, but also in less number of lost castings and higher quality of accepted product?

Last spring, the American Foundrymen's Association decided that thorough study of this subject would be profitable and asked the coöperation of the American Institute of Mining and Metallurgical Engineers. The Institute referred this request to the Division of Engineering of the National Research Council, of which it is a member. Through joint action with the division a valuable digest of the literature has been made by Professor Robert E. Kennedy, of the University of Illinois, and a large committee of foundrymen, engineers and scientific men has been selected, under the general direction of President W. R. Bean, of the Foundrymen's Association and the chairman of the division.

This committee on molding sand research has just been organized with the following officers and executive committee:

Chairman: R. A. Bull, consulting engineer, Sewickley, Pa.

Secretary: Robert E. Kennedy, assistant secretary of the American Foundrymen's Association, Urbana, Illinois.

W. R. Bean, president of the American Foundrymen's Association, Naugatuck, Conn.

Henry B. Hanley, metallurgist and chemist, New London, Conn.

Jesse L. Jones, metallurgist of the Westinghouse Electric and Manufacturing Co., E. Pittsburgh, Pa.

Prof. Henry Ries, Department of Geology, Cornell University, Ithaca, New York.

Dr. Bradley Stoughton, consulting engineer, New York City.

Dr. George K. Burgess, chief of the Division of Metallurgy, Bureau of Standards, Washington, D. C.

The committee has thirty-five members, representing the many interests in the use of molding sand.

At a meeting of the executive committee on November 26, in the office of Division of Engineering, Engineering Societies Building, New York City, three subcommittees were appointed to deal (1) with the formulation of standard tests for determining the working properties of molding sand, (2) reclamation of molding sands and greater use of old sands and (3) methods of manufacturing synthetic sands. A meeting of the main committee in the Engineering Societies Building, New York, was planned for December 9, to lay out a comprehensive program of research which will include the assigning of the various problems to appropriate laboratories and industrial plants. Some field work will be necessary in connection with these investigations.

The coöperation of men having like interests in Canada and England is assured and invitations have been extended to France and Belgium. Address Alfred D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th Street, New York.

Foundry Equipment, Materials and Methods B2-22. ELIMINATION OF OXIDIZIBLE ELEMENTS IN CAST IRON. John H. Moffett, formerly metallurgical engineer at the University of Cincinnati, is now in charge of the foundry practice in the Department of Mechanical Engineering at the University of Minnesota. He is at present carrying on a research on the Relative Rates of Elimination of Oxidizible Elements in Cast Iron. Address Professor Moffett at the University of Minnesota.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire cooperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring cooperation or aid will state problems for publication in this section.

Highways C1-22. COORDINATION OF HIGHWAY RESEARCH. *See Road Materials and Equipment C1-22.*

Road Materials and Equipment C1-22. COORDINATION OF HIGHWAY RESEARCH. Mr. W. K. Hatt, a member of the Advisory Board on Highway Research of the National Research Council, discusses this subject completely in a paper read at the meeting of the American Association of State Highway Officials, Omaha, Neb., December, 1921. He discusses first the present situation in highway research and then points out how the various state highway commissions may assist in developing as rapidly as possible the data which can be a safe foundation for the scientific construction and operation of highways. Address A. D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th St., New York.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure of commercial work or notes regarding the conduct of various laboratories.

Research Agencies E1-22. Personnel Research Agencies. The Bureau of Labor Statistics of the U. S. Department of Labor has just issued a 107-page Bulletin No. 299 in which it has attempted to provide information about all existing agencies in the United States in the field of Personnel Research. Personnel research has been construed to include within its scope studies and investigations of all kinds concerned with any of the problems of (*a*) employment management and industrial relations (such as selection and placement of employees, job analyses and specifications, rating and grading, lines of promotion, labor turnover, absenteeism, wage and other incentives, joint control, etc.); (*b*) vocational psychology, including the development and standardization of intelligence and trade tests; (*c*) training of managers, foremen and workmen, either in schools and colleges, in the factory, or under schemes of coöperation between educational institutions and industrial establishments; (*d*) working conditions in relation to output, including hours of labor, fatigue, lighting, ventilation, food; (*e*) health hazards and occupational diseases; (*f*) safety codes and appliances; also the special problems connected with the employment of women and young persons, foreign-born workers and colored workers, the handicapped or disabled, and the mentally deficient or unstable. The agencies whose activities are described are arranged in the following main divisions:

1 Official agencies: (*a*) Federal, (*b*) State, (*c*) Municipal.
2 Non-official agencies: (*a*) Associations, foundations, research bureaus, and institutions; (*b*) Universities and colleges.

Address Bureau of Labor Statistics, Washington, D. C.

Research Agencies E2-22. New Division of Coöperative Research. Under the Directorship of Dr. W. V. Bingham, the Carnegie Institute of Technology has recently organized a Division for Coöperative Research. This is new evidence of efforts of the Institute to foster research of the highest order in all the scientific and technical departments of the Institute. The plan and purpose of the organization of this new activity of the Carnegie Institute is outlined in the November, 1921 issue of "*The Carnegie Technical Journal* under the heads, The Need for a Research Center, Industrial Problems, Commercial Problems, Educational Research, and Organization and Program of the New Division. Address Carnegie Institute of Technology, Pittsburgh, Pa.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Cement and Other Building Materials F1-22. Acid-Proofing of Concrete. A bibliography of 2½ pages. Search 3472.

Cement and Other Building Materials F2-22. Waterproofing of Concrete. 5½ pages. Search 3473.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 375 and 376, as formulated at the meeting of December 6, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 375

Inquiry: Is it permissible, under the requirements of the Boiler Code, to weld a seam in a vertical firebox not over 38 in. in diameter, and in length ranging from 20 in. up, by the autogenous or fusion process where the firebox has no support other than the tube sheet, mud ring and fire door?

Reply: It is the opinion of the Committee that, under the requirements of the Code, autogenous or fusion welding is not permissible for the seam in the firebox of a vertical-tubular boiler, unless the sheet containing the seam is supported by staybolting.

Case No. 376

Inquiry: An interpretation is requested of the limitation of 50 hp. in Par. 318 of the Boiler Code to different classes of boilers. Is it the intention that the horsepower capacity be based on water heating surface as specified in the requirement in Par. 274?

Reply: It is the opinion of the Committee that the intent of Par. 318, relative to the determination of the feeding devices required for boilers, will be met if boilers having over 500 sq. ft. of water-heating surface are provided with two or more feeding devices.

Boiler Code Sub-Committee on Code for Care of Steam Boilers in Service

When the A.S.M.E. Boiler Code Committee was appointed in 1911, it was given the following title: Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for Their Care in Service. Since its inception however, the great volume of the Committee's work has been devoted to the formulation of rules for the construction of steam boilers of different classes and little opportunity has been given to consider the important problem of their operation.

Realizing this lack in the Committee's function, attention has recently been given to the need for operating rules and there was appointed by the Council at the meeting of January 7, at the request of the Boiler Code Committee, the following Sub-Committee for this purpose:

F. M. Gibson, *Chairman*, Boston, Mass.
H. F. Scott, Framingham, Mass.
J. R. Gill, Meadville, Pa.
W. H. Larkin, Jr., Passaic, N. J.
J. Wolff, Cleveland, O.
W. G. Diman, Manchester, N. H.
J. S. Schumaker, Lincoln, N. H.
E. G. Bailey, Cleveland, O.
J. W. Hays, Michigan City, Ind.
S. F. Jeter, Hartford, Conn.
Nicholas Stahl, Providence, R. I

This Sub-Committee consists of active operating engineers who have had long and varied experiences and are eminently fitted for the preparation of rules for the care of boilers in service. The code which they may formulate should be welcomed by all boiler owners, insurance companies and in fact anyone directly or indirectly interested in the field of steam boilers or other pressure vessels.

The Boiler Code Committee desires coöperation in this new department of its activities and requests everyone interested to assist in this important work for the general good. Mr. F. M. Gibson, to whom the Committee is indebted for the active effort in inaugurating this work and who has been appointed Chairman, will greatly appreciate the assistance of all those who may contribute.

He should be addressed care of the American Sugar Refining Co., 49 Granite St., South Boston, Mass.

Bombing of the U. S. S. "Ex-Iowa" and the Former German Ships

By COMMANDER F. J. CLEARY,[1] U. S. N.

IN agreeing generally to Mr. Elmer A. Sperry's editorial on "What the Virginia Capes Aircraft Bombing Test Show" in the September, 1921 issue of MECHANICAL ENGINEERING I desire to point out that some of his statements taken by themselves are susceptible of erroneous conclusions. The bombing experiments are of sufficient value to warrant presentation of the facts observed and the conclusions reached by the Board of Observers and by the Army and Navy Joint Board.

The bombing of the U. S. S. ex-*Iowa* and of the ex-German ships, including the *Ostfriesland*, was conducted by the Naval Air Force of the Atlantic Fleet under Admiral Henry B. Wilson, Commander-in-Chief. The Army was invited to participate and did so by a Provisional Air Brigade operating under the orders of the Commander-in-Chief, Atlantic Fleet. The plans for the experiments were set forth in Fleet Operations Order 261-24-5 of May 25, 1921, from which the following extracts are taken:

"Vice Admiral H. P. Jones, Commander Battleship Force, is in charge of operations scheduled."

"The Commander of the Air Force Atlantic Fleet is charged with the operations of all Air Forces engaged."

"Brigadier General William Mitchell, U. S. Army, has been designated by the War Department as the Commander of the Army Provisional Air Brigade and is in immediate command of all Army Air Forces engaged in these exercises."

The *Ostfriesland* was 50 miles from the coast, and the attacking planes were guided to the target by a double line of destroyers stationed for that purpose and to aid any planes taking the water.

The ex-*Iowa* was approximately 100 miles off shore, and the search for and the bombing of her were conducted by Navy planes. Three army blimps took part in the search operations. The Army was invited to take part in the bombing of the ex-*Iowa*, but did not.

The Army was also represented on the Board of Observers, composed of 13 Naval Officers (ranking from Captain down to Lieutenant Commander) and 6 Army Officers (Lieutenant-Colonels and Majors), 3 of the Army Air Force and 3 of the Ordnance Department.

The *Ostfriesland* was turned over to the U. S. with the understanding that she would be sunk, and the bombing experiments were planned to cause as much destruction as possible so that any weak features of construction would be revealed. She was an old ship, laid down in 1909 and launched in 1911, and displaced 24,000 tons, and her protection above and below water was much less effective than in a modern ship. She had no anti-aircraft gun fire and could not maneuver to avoid attack, and the planes bombed from the extremely low altitude of 1200 to 2000 ft. The ship had been badly damaged by the Germans before she was delivered. She leaked to such an extent that on the trip down from New York to her anchorage she took in 1020 tons of water increasing her draft one foot.

The bombing on the first day lasted from 1:40 to 4:25 p.m., during which time 52 planes, both singly and in formation, made 31 flights over her, dropped 52 bombs and made 13 direct hits as follows:

Navy	33–230-lb. bombs	8 hits
Navy	8–550-lb. bombs	4 hits
Army	11–600-lb. bombs	1 hit

At the end of the first day's bombing, the ship had received little damage from the direct hits, except a hole in the starboard side of the forecastle made by a 600-lb. bomb which caused some general damage to light fittings under this deck. A few holes were made by fragments in the second deck, but this second deck practically stopped the whole force of the explosion. No damage whatever was done to the protective deck.

A number of these bombs had fallen close aboard. Examination below showed 7 of the 9 fire rooms clear of water, one fire room could not be entered, the other was taking in water. Two out of the three engine rooms were taking in water. This water was from the old leaks and from new leaks, but the water was coming in so slowly that the ship could have been pumped out by the powerful outfit of pumps which are a part of the machinery equipment of all naval ships. The ship took in water during the night so that the next morning her draft had been increased by an additional 3 ft., showing that she now had 4080 tons of water in her (which could have been kept clear had she been in good condition at the beginning and had the pumps been operating), bringing her water line within 1 or 2 ft. of the 3d-deck air ports.

Bombing with 1000-lb. bombs commenced at 8:30, and during the morning 11 Army planes made 11 single flights over her, dropping 11 1000-lb. bombs and making three direct hits. A careful inspection was made. The three direct hits caused no vital damage to the ship and none to her main battery; two of these 1000-lb. bombs detonated between the two starboard waist turrets but no damage to the turrets resulted. The other bomb blew a hole in the starboard side of the forecastle extending down near the water line. This injury would have undoubtedly affected the speed of the ship; there was no bursting effect below the 2d deck and all fragments were stopped by the protective deck. The damage in every case where bombs struck the ship was purely local; the vertical blast effect was considerable but the horizontal blast effect was so comparatively slight that a 1 inch steel bulkhead about 25 ft. from the point of impact would have afforded protection to personnel. No damage was suffered to the battle lighting and battle control systems and absolutely no damage was caused behind armor or below the protective deck. By noon, from the water taken aboard through the leaks, the ship was down 5 feet by the stern.

Bombing with the 2000-lb. bombs was commenced at 12:30 in 12½ min. 6 bombs were dropped—there were no direct hits. Three bombs dropped far enough away to do no damage; the other three dropped very close alongside, one detonated very close to the port bow but appeared to do no appreciable damage; the third detonated under water close to the port quarter severely damaging the already weakened port side and at the same time blew in the glass air ports of the gun deck and 3d decks aft, these ports being awash and not fitted with steel battle covers as is usual. This allowed a heavy rush of water into the already waterlogged hull. The vessel began to settle rapidly by the stern, listed heavily to port, and at 12:40 she turned completely over and went down by the stern throwing her bow high in the air.

In all the following bombs were dropped on the *Ostfriesland:*

		Direct hits
33	Navy- 230 lb.	8
8	Navy- 550 lb.	4
11	Army- 600 lb.	1
11	Army-1000 lb.	3
6	Army-2000 lb.	0
69		16

The damage done by the bombs was identical to the damage that would have been caused by mines.

The mining effect on the underwater structure by the bombs which detonated under water close to the ship, together with the flow of water through the equalizer pipes and the fire-room doors (which were opened by the Board of Observers to keep the ship on an even keel) and the rush of water through the blown-in glass air ports caused her to sink finally. All this was cumulative, and it is probable that if she had been manned, her pumps could have controlled the leakage resulting from all attacks but the final one, and consequently the mining effect of the final attack would have been greatly reduced, and it is very possible that sinking might not have resulted from the damage inflicted by all of these attacks. Our latest capital ships are so constructed that the damage from these attacks would have been very much less than that inflicted on the Ostfriesland.

At an immovable target 548 ft. long by 94 ft. beam and at the low altitude of 1200 to 2000 ft. 16 direct hits were made out of 69 shots, the misses varying from close aboard to 300 ft. distant.

(*Continued on page 135*)

[1] Bureau of Steam Engineering, Washington, D. C.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

The Development of the Colorado River

The convention of the League of the Southwest at Riverside, California, on December 8 to 10 and the hearing on the Boulder Canyon Project before Secretary Fall at San Diego on December 12 has aroused general interest in the various proposals which have been made for the development of the Colorado River. The basin of this river includes parts of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, and has an area of about 250,000 square miles. It contains some five million acres of irrigable lands, and has power possibilities aggregating six million horsepower. Its most pressing problem, however, is flood protection.

Clinedinst
O. C. MERRILL

The Gulf of California originally extended northwestward into California. The silt-laden water of the Colorado gradually formed a delta extending across the Gulf, cutting off the northern end, and deflecting the flow of the river wholly to the south. The waters inclosed in the northern and evaporated leaving a depression, now known as the Imperial Valley, and the Salton Sea with its surface 250 ft. below sea level. The silt-formed delta is unstable; the river is constantly depositing more sediment and shifting its channel back and forth over the flat ridge—some 30 ft. above sea level—which forms the crest of the delta; and there is danger at each flood season that it may break northward into the Imperial Valley instead of continuing southward into the Gulf. The river did break through in 1905 and for a year and a half discharged into Salton Sea before it was turned back with great difficulty and much expense into its old channel. The levees which were later built to protect the valley have several times been awash in periods of floods; it is necessary to raise them about a foot a year to keep pace with the rise of the river channel; and it is only a matter of time when the river will break through again unless steps are taken to control the floods. It is this situation which has placed primary emphasis on flood control in all plans for the development of the Colorado River.

Less than one acre in thirty in the Colorado Basin is irrigable. The general development of the basin will, therefore, be likely to require all the agricultural products that its lands can produce long before there will be a demand for all its potential water powers. For this reason irrigation is secondary only to flood control in a general plan of development, and irrigation use of the waters of the stream will take precedence over power use wherever these uses conflict.

Although the Colorado Basin has important mineral resources, only partially developed on account of lack of power and of transportation, and has several lines of trunk railroads and many flourishing towns and cities, all of which would serve to create a demand for power, the individual markets would be so small and so widely scattered that it is hardly probable that the requirements of the basin itself would justify any large-scale development on the main river at the present time. Such a development must first seek primary markets outside the basin. The only section which seems capable of furnishing the requisite demand in the near future is Southern California; and all proposals for extensive development on the river have that territory in view. If, however, primary lines are once established and the main load secured, extension of service will be made into the local territory, provided the projects are operated by agencies which have the authority and the disposition to extend their lines for such purpose.

Applications for power projects on the Colorado and its tributaries aggregating 4,500,000 primary horsepower are now on file with the Federal Power Commission. The most important of the proposed projects are the Lees Ferry Project of the Southern California Edison Company, the Diamond Creek Project of James B. Girand, and the Boulder Canyon Project of the United States Reclamation Service. The first proposes a dam near Lees Ferry of approximately 500 feet in height forming a reservoir 125 miles in length with a capacity of 30 million acre feet and capable of producing 600,000 horsepower from the regulated flow of the stream. The Diamond Creek Project involves a dam some 250 feet high, has no provision for seasonal storage, and would be capable of producing some 125,000 horsepower from the unregulated flow of the stream. The Boulder Canyon Project proposes a dam 550 feet in height forming a reservoir of 30 million acre feet capacity. This project, while intended primarily for flood control and irrigation would be capable of producing 600,000 horsepower. The Boulder Canyon Project is approximately 250 miles from Los Angeles, and the Lees Ferry Project 450 miles. The Diamond Creek Project midway between the other two is intended primarily for supplying power in Arizona.

The general problem of the Colorado River Development and the relation to each other of flood control, irrigation and water power can best be understood by reference to the accompanying map and profile and by a consideration of the different characteristics of the upper, middle and lower sections of the river. The upper section from the headwaters to the mouth of the San Juan comprises about 40 per cent of the area of the basin and affords about 87 per cent of the total runoff, or an average of 15,000,000 acre ft. per annum. In this section are some 2,500,000 acres of irrigable land, one-half of the total in the basin. It also has power possibilities aggregating 2,000,000 horsepower. In this section, both upon the main stream and upon its tributaries are many favorable reservoir sites by means of which it would be practicable to regulate the flow of the streams for irrigation within the section, for power development both within the section and outside, and, if desirable, for flood control on the lower river.

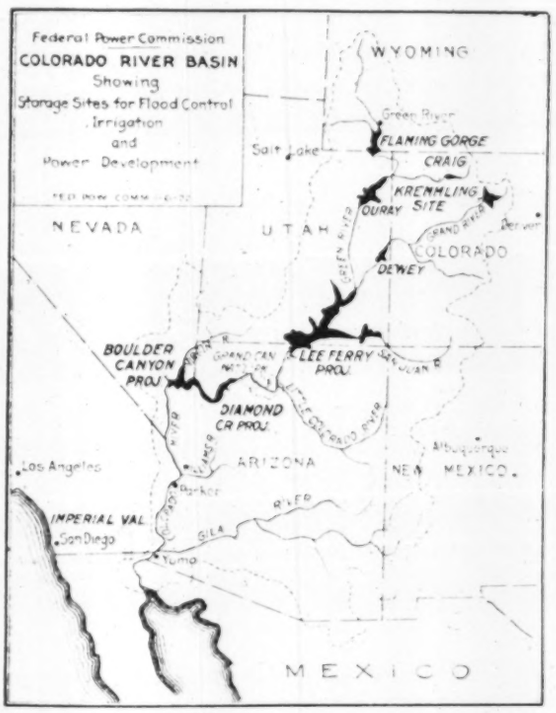
The middle section from the mouth of the San Juan to the mouth of the Williams comprises about 35 per cent of the area of the basin and supplies about 7 per cent of the annual runoff. There are no irrigable lands along the river in this section and only 250,000 acres on the tributaries, none of which can be reached from the main river. In this section, however, there is a total drop of some 3,000 ft., capable, if fully utilizing the average annual runoff entering the section, of producing 4,000,000 horsepower. Except for the Boulder Canyon Site near the lower end of the section there are no feasible storage sites. Dams erected for power development would be primarily for the purpose of concentrating the head and of providing daily load regulation. Seasonal regulation would be dependent upon storage in the upper section.

The lower section from the mouth of the Williams River to the Gulf, and including the drainage of the Gila and the Imperial and

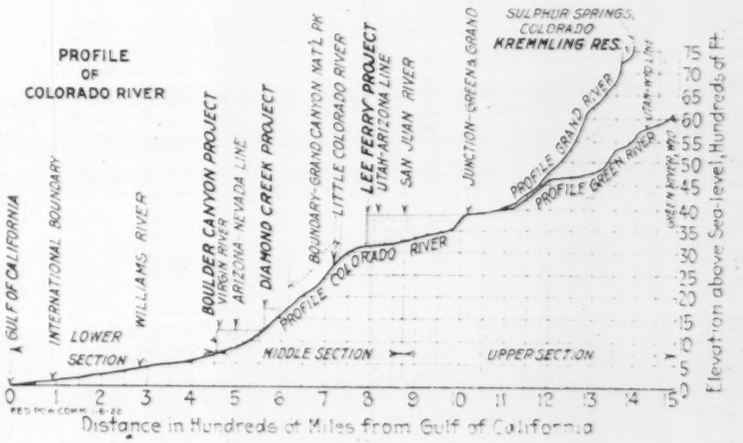
Coachella valleys in California, comprises some 25 per cent of the total area of the basin and furnishes about 6 per cent of the average annual runoff. Its power possibilities are relatively unimportant, but it contains some 2,250,000 acres of irrigable land, the most fertile and most valuable in the basin.

Viewed solely from the physical standpoint, the upper section of the basin might have its primary development directed either toward irrigation or toward water power. On the other hand, the middle section, with the exception of storage below the mouth of the Virgin and of relatively small irrigable areas on the tributaries, is suitable only for power development. Equally clearly the lower section should be devoted primarily if not exclusively to irrigation. The primary elements of a general plan for river development for the several purposes are, therefore, storage at the headwaters for irrigation and power in the upper section, storage below the San Juan for the regulation of the waters available at that point for power use in the middle section, and storage below the Virgin for re-regulation to meet irrigation requirements and flood protection in the lower section. If these can be provided, and an equitable distribution of irrigation waters between the upper and lower sections effected, the fullest utilization of the stream can be effected with the least conflict of use.

There seems to be a reasonably close agreement on the general features of a plan of development. Such disagreement as has appeared has had reference to the order in which the various steps



of the general plan should be undertaken and to the agencies which should carry it out. It is agreed that flood control is the most pressing problem. This could be effected by storage in the upper section,—which was the original proposal—but such a plan would require the use of several of the best reservoir sites in this section, and would render them practically useless for irrigation or power development. Flood control could also be effected by storage either below the mouth of the San Juan at the upper end of the middle section or at Boulder Canyon at the lower end of the section. Storage primarily for flood control and irrigation at the former location would at the same time provide all the regulation likely to be needed for many years for power development below although eventually when power demands called for the entire use of the upper reservoir for such purposes, storage below the Virgin would be required for re-regulation to meet the needs of irrigation and flood control. On the other hand, if the sole dependence for flood control and irrigation storage is to be placed on the Boulder Canyon site, the investment must be duplicated above in order to provide regulation for power purposes in the middle section, and when this has been done the greater part of the storage capacity at Boulder Canyon will be valueless, unless the excess cost can be justified wholly from the standpoint of the power



which may be produced, or unless the imminence of flood danger to the Imperial Valley and the time element in favor of Boulder Canyon justify the additional cost as a measure of insurance.

It was the consensus of opinion at the San Diego hearing that the Boulder Canyon dam, at least, should be built and owned by the United States and that the power produced should be disposed of by the United States. The Boulder Canyon site is estimated to be capable of producing 500,000 horsepower, and the only market for such a block of power at the present time is in Southern California. Under such circumstances there is not likely to be any further move made toward large-scale development upon the river until Congress either approves or disapproves the proposal for Government construction and, if it approves, until the question of the distribution of the power is settled. The municipalities of Southern California, particularly Los Angeles, are making a strong bid for this power. If they secure it, it will be taken out of the basin, will not be a factor in the development of the basin itself, and the other six States which have not the means to enter upon a program of public development will either have to wait until local demands have increased to an amount which will justify private capital in undertaking the service, or depend upon the Federal Government to supply their needs from Boulder Canyon or elsewhere.

O. C. MERRILL.[1]

A.S.M.E. Announces Spring Meeting Plans

At the meeting of the A.S.M.E. Council held in Norfolk, Va., on January 7, the Committee on Meetings and Program received full support in its stand that papers for the 1922 Spring Meeting must be in hand before March 15. This action was taken to permit the Committee to give proper consideration to contributions for the meeting. The time limit is also set to insure printing and issue previous to the meeting. In this way proper discussion is provided and it is the consensus of opinion that discussion is necessary to the life of a meeting. At the last Annual Meeting, papers were ready only a few days before the professional sessions started and as a result, some of the notable papers did not receive the study their contents really required. Many members expressed dissatisfaction which it is believed this Council action will remove in the future. It should be borne in mind, however, that March 15 is the last date that papers will be accepted. All of the papers can not be properly handled if they arrive at the last moment, and the Committee on Meetings and Program will exercise its judgment as to the papers that should be printed.

The adoption of this procedure at this time is especially fortunate as it will give considerable strength to the program of the Spring Meeting at Atlanta.

An exceedingly interesting Spring Meeting week has been tenta-

[1] Executive Secretary, Federal Power Commission, Washington, D. C.

tively decided upon by the A.S.M.E. Committee on Meetings and Program. The festivities will start at the University of Virginia on Friday and Saturday, May 5 and 6, preceding the meeting. This will give an opportunity to members attending from the North to stop over and enjoy the hospitality of the Virginia Section. The program at Atlanta will start on Monday, May 8, and will extend through May 11. The Atlanta Section is offering a remarkable program of entertainment in which a real southern barbecue and exhibition golf match will be offered. The climate in Atlanta at that time of the year is very pleasant and those coming from other sections of the country not so well favored will enjoy the week out of doors well in advance of the open season in the North.

The technical program in Atlanta will include papers furnished by the Power, Fuels, Materials Handling, Management, Machine Shop and Textile Professional Divisions.

The Power Division will present a program relating to hydro-electric power development, particularly in the Southeast. A paper giving the results of recent tests on the 60,000 kw. turbine of the Interborough Rapid Transit Company of New York City will be presented by title.

The Fuels Division promises three papers as follows:

Relation of combustible elements of coal to the oxygen content and the establishment of a fuel unit of practically constant heat value for over 90 per cent of all bituminous coals, E. A. Uehling. Boiler Room Performance and Practice at the Colfax Station of the Duquesne Light Company and the Seward Station of the Pennsylvania Public Service Corporation, G. W. E. Clarke. Reduction of Fuel Wastes in the Steel Industry, F. G. Cutler.

Materials Handling Equipment in the Steel Industry is the subject of a paper to be given before the Materials Handling Division by F. L. Leach of Perin and Marshall. Mr. Leach has treated the entire industry in a comprehensive manner and shows how its operation hinges on adequate design of equipment.

The programs of the Management, Textile, and Machine Shop Divisions treats of the problems of the textile industry. The Management Division plans three papers as follows: Comparison of Southern white labor with foreign labor of the North, Frank H. Neely. General subject of management in textile plants, George S. Harris. Reducing costs in textile mills by increasing production, E. A. Lucey.

The Machine Shop and Textile Divisions will coöperate in joint sessions on textile machinery. The papers will discuss textile machinery maintenance, weaving, ginning, and carding machines.

After the sessions at Atlanta those interested in seeing textile plants in operation will visit Greenville, S. C., where thorough inspection trips will be held. Other members of the Society will be given an opportunity to take a trip to Birmingham, Ala., where the remarkable series of plants engaged in the manufacture of iron and steel will be inspected.

Patent Relief Bill Passes House

As we go to press, word is received from Chairman Edwin J. Prindle, of the American Engineering Council Committee on Patents, advising that the Lampert Patent Office Bill has passed the House of Representatives. This is the first step in securing the much needed relief in the Patent Office for which the American Engineering Council has been struggling for considerable time.

Engineering Societies Library Now Loans Books

In the book column on page 139 Director Craver of the Engineering Societies Library explains the plan by which members of any of the Societies participating in the library may have books loaned to them.

In the early days of the Society when the membership was not so widely scattered or its interests so diversified, the library privileges were more generally appreciated than at the present time. Technical book publications, which are usually expensive, are still needed for reference and this new attempt on the part of the Library to satisfy the demand from outside the environs of New York City is particularly noteworthy. This step is along the line of the photostat and search services in placing the resources of the library at the disposal of the individual members of the profession.

Industrial Standardization

E. C. Peck

We are apt to think of mass production as primarily an American development, but the experiences of the War brought its possibilities home to the leaders of industry in the principal European countries, even if all of them had not realized its significance before. Today there are being planned and carried out in each of these countries, far-reaching programs of industrial standardization. In a large measure, the work is national in its scope. That is to say, any particular piece of work is carried out through the systematic coöperative effort of the industries concerned, functioning through their national industrial associations, technical societies, and government bureaus.

The two countries in which such work has reached its greatest development, both in scope and in activity, are Great Britain and Germany. A description of the German work is presented on page 136 of this issue. The Germans, taking full advantage of the lessons of the War, are making industrial standardization an essential part of their scheme of reconstruction and are relying on it to play an important role in rebuilding their foreign trade on a vastly increased scale. Managers of American industries may well give serious study to the German work. It behooves them to intensify their efforts toward standardization, or they will be left behind in the competition for world commerce. It is not enough that there be standardization work done by sections of industries and by individual firms, although such work, prior to the War, made possible a considerable amount of mass production, which attracted the attention of European industrialists. To reap the full benefits the work must be broadened and intensified, and made national in its scope. This requires the joint effort of manager and engineer, of producer, distributor, consumer and independent specialist, all speaking through the organized bodies which represent their interests. Fortunately such industry-wide coöperation has already been brought about in a large number of projects now going forward under the auspices of the American Engineering Standards Committee, and very substantial results have already been achieved. It must be evident that considerable prestige is acquired by manufacturers whose products are in accord with the standards that have been established by national organizations and especially those approved by the American Engineering Standards Committee.

The many benefits of standardization are by no means limited to the production side. In the long run standardization is bound to be of even greater importance in the reduction of distribution and selling costs,—perhaps the most important problem of our economic system. A comprehensive program of standardization planned and carried out by our great national industries will mean the saving of hundreds of millions—even billions of dollars.

E. C. Peck[1]

Ordnance Department Needs Manufacturers' Aid

With the passing of emergency, the Ordnance Department of the Army, which during the war was able to enlist close and hearty coöperation from manufacturers of ordnance material and mechanical engineers generally, is now finding it difficult to secure from private industry the assistance which is so necessary if the most practical types of ordnance material are produced. It is essential to the national interest that this apathy on the part of outside manufacturers be broken down, in the opinion of Brigadier General W. S. Peirce, assistant chief of Ordnance, in immediate charge of the work which involves this problem. He is at this time making a renewed effort to solve this problem.

General Peirce believes that a widely held view that ordnance specifications are too theoretical, can be offset entirely if machinery and material manufacturers can be interested sufficiently to go into the subject deep enough to understand the military problems involved.

[1] General Supt., Cleveland Twist Drill Co., Chairman A.S.M.E. Standardization Committee.

BOMBING OF THE U. S. S. "EX-IOWA"

(Continued from page 131)

That accuracy of bomb dropping rapidly decreases with increase of altitude and a moving target is proved by the bombing tests on the ex-*Iowa* a few days earlier when 22 planes bombed her from 11:24:00 a.m. to 3:10 p.m. from an altitude of 4000 ft. dropping 85 (dummy) bombs and making 2 direct hits, the 83 misses varying from close aboard to 600 or 700 ft. distant. The speed of the ex-*Iowa* was only 6 knots which should have had little or no effect upon the accuracy of bomb dropping.

The problem of avoiding a bombing plane by maneuvering or of hitting a bombing plane is much simpler than avoiding or hitting a plane not bombing for the reason that the bombing plane must steady on a course heading almost directly toward the target for an appreciable period and the position at which the bomb must be released can be forecast with fair accuracy.

If the *Ostfriesland* had been underway at 20 knots or more and if her anti-aircraft battery had been in action, keeping the heavy bombing planes at a safe altitude of 6000 ft., it is reasonable to believe that the chance of serious damage would not have been very great from the 69 bombs which were dropped at her during the two-days attack. If, in addition, she had carried three or four fast pursuit planes (with machine guns firing explosive and incendiary bullets), as all capital ships now carry or will carry, these fast planes would have outmaneuvered and shot down a number of the bombing planes before they arrived within bombing distance.

The Navy has known for many years that any ship could be seriously damaged or sunk by detonating heavy charges of high explosive under water against or very close to the body of the ship below armor. Such damage from mines or torpedoes has been guarded against by numerous watertight bulkheads or by the British "blister" until the latest capital ships can survive direct hits from two or three torpedoes or the explosion of two or three heavy mines fairly close aboard.

If the explosion takes place beyond a certain distance from the ship (depending upon the weight of the explosive charge and its distance below the surface) little or no damage will result. The distance within which a charge of high explosive must be placed to seriously damage the thin plating below armor is comparatively very short; for instance—a 250- or 300-lb. bomb detonated under water probably within 15 or 20 ft. of the hull of the light cruiser *Frankfort* without appreciable effect.

The Navy fully believed that very heavy charges of high explosives could be detonated on the upper decks of a modern capital ship with no damage to turrets or other heavy fittings, and while such heavy charges would probably penetrate the upper decks, the heavy protective decks would render the propelling machinery, boilers, magazines, and the greater part of the personnel immune, from overhead attack.

This knowledge and this belief have been confirmed by the experiments on the ex-*Iowa* and the *Ostfriesland*, and the Navy faces the same problem—to keep high explosive charges from detonating under water within the comparatively short danger space of the underwater body below armor.

Under the same conditions, i.e., a stationary target and immunity from hostile fire, an attack by destroyers, by submarines, or by another battleship would have resulted in sinking the Ostfriesland in a very short space of time.

The experiments demonstrated that the airplane is a powerful weapon of offense, capable under favorable conditions of placing heavy charges of high explosive sufficiently close to a capital ship to sink her eventually. The airplane menace to the capital ship is commensurate with the destroyer menace and the submarine menace. The destroyer menace was met by numerous watertight bulkheads, rapid fire guns and protecting destroyers; the added submarine menace was met by the added protection of listening devices, depth charges, speed and quick maneuvering, the added airplane menace is being met by the added protection of (first and most important) fast pursuit planes, and anti-aircraft batteries.

The Joint Army and Navy Board consists of the following very able and experienced officers: General Pershing, Chief of Staff; General Harboard, Director of the Operations Division, General Staff; General Haan, Director of War Plans Division, General Staff; Admiral Coontz, Chief of Naval Operations; Admiral Williams, Director of Plans Division, Naval Operations; Captain Cole, Assistant Chief of Naval Operations. This Joint Board, from a careful study of the reports of the Boards of Observers, from actual observations by some of the members of the Joint Board of the bombing experiments, and from their general knowledge of the principles of war and methods of conducting war, arrived at certain general conclusions. These general conclusions are concurred in by a large majority of officers of both the Navy and the Army who have had access to the report of the Joint Board. These general conclusions have been approved by the Secretary of War and the Secretary of the Navy and are quoted below:

"Aircraft either singly or in combination have pronounced ability to search sea areas within their radius of action and to locate naval vessels operating in such areas. When armed with heavy bombs the radius of action of heavier-than-air types is inadequate for extensive search operations. Darkness, fog, falling or squally weather will greatly reduce the effectiveness of aircraft in search operations.

"Inasmuch as these experiments were not conducted under battle conditions it is difficult to draw conclusions as to the probability of hitting a target with bombs from aircraft while in action. Under the favorable conditions existing during the experiments, namely stationary or practically stationary targets, immunity from enemy interference, excellent visibility and flying conditions, the percentage of hits was greatly in excess of that to be expected under battle conditions. The probability of hitting will be reduced in the case of a target moving at high speed on varying courses; further reduced if the target vessel is protected by effective anti-aircraft armament; and will be practically negligible if the target is protected by effective pursuit planes. The effectiveness of the bomb carried by aircraft emphasizes the necessity for the rapid development of anti-aircraft armament and the provision of pursuit planes as a part of the fleet. Aircraft carrying high-capacity high-explosive bombs of sufficient size have adequate offensive power to sink or seriously damage any naval vessel at present constructed provided such projectiles can be placed in the water alongside the vessel. Such bombs hitting the upper works of the vessel are disastrous to exposed personnel, serious to light upper works, comparatively slight to heavy fittings such as guns, and negligible to turrets. The effect of direct hits was completely local. In the case of capital ships, the mining effect of bombs will be materially reduced due to the ability of the personnel to free the ship of large quantities of water by means of pumps and to shore up watertight doors and bulkheads which are in danger of carrying away due to water pressure. Aircrafts possess sufficient offensive power to seriously threaten the exposed personnel of naval vessels unless such vessels are protected by pursuit planes. This emphasizes the necessity for the further protection of personnel and for the provision of aircraft carriers to accompany the fleet.

"The radius of action of bombing planes limits their effectiveness against Naval vessels to coast defense or base defense.

"The mission of the Navy is to control vital lines of transportation upon the sea. If no opposition is met from enemy naval vessels this mission can be accomplished without entering an enemy's coast zone within which bombing aircraft based on shore are effective.

"Without an effective Navy in time of war a nation must submit to an economic blockade fatal to its trade and the importation of necessary materials for the production of war supplies.

"If heaver-than-aircraft are to be effective in naval warfare they must have great mobility, and since their radius of action is not great, additional mobility must be obtained by providing aircraft carriers. So far as known, no planes large enough to carry a bomb effective against a capital ship have been flown from or landed on an airplane carrier at sea. Future development may make such operations practicable. Aircraft carriers are essential to the highest efficiency of the fleet. Aircraft carriers are subject to attack by vessels carrying guns, torpedoes or bombs, and will require, as all other types of vessels require, the eventual support of the battleship.

"The battleship is still the backbone of the fleet and the bulwark of the Nation's sea defense, and will so remain as long as safe navigation of the sea for purposes of trade or transportation is vital to success in war. The airplane, like the submarine, destroyer and mine, has added to the dangers to which battleships are exposed, but has not made the battleship obsolete. The battleship still remains the greatest factor of naval strength. The development of aircraft, instead of furnishing an economical instrument of war leading to the abolition of the battleship, has but added to the complexity of naval warfare.

John J. Pershing,
Senior Member.

Approved
Theodore Roosevelt,
Acting Secretary of the Navy.

Approved
John W. Weeks,
Secretary of War."

Every new development in naval warfare has its advocates who have predicted that the battleship was doomed. First, the small torpedo boat was to render the battleship obsolete; next the fast destroyer, then the submarine, and now the airplane—each new challenge to the supremacy of the capital ship has been met by the development of the defense and by adopting and adapting the challenger as an efficient auxiliary to the capital ship, and the Navy is dealing with the airplane in the same manner as it has successfully dealt with the torpedo boat, the destroyer and the submarine.

Engineering and Industrial Standardization

Industrial Standardization in Germany

INSUFFICIENT attention has been given to the role which standardization is playing in German industrial reconstruction. The German industries are planning and are carrying out a far-reaching program of standardization as a necessary step in building up an unprecedented industrial structure which must rest in large measure on an extensive foreign trade. In no other country except Great Britain is standardization work being carried on upon a scale, or with an intensity, comparable to that in Germany.

The German work is of special interest to those responsible for the management of American industries, not only because of its importance, but also because of the similarity in the historical conditions surrounding the national standardization movements in Germany and in America.

Prior to 1917 a vast amount of standardization work had been carried out in Germany by individual companies, and by engineering societies and industrial associations, but, as was the case in America before the organization of the American Engineering Standards Committee, the work had not been unified along national lines.

As has been the case with all the other national standardizing bodies except the British, which was organized in 1901, the success of the standardization work carried out by the various countries during the World War as a part of their national conservation programs, was a chief cause of the formation of the Central German Body. It is called the Normenausschuss der Deutschen Industrie, and was organized by the Verein deutscher Ingenieure, at the suggestion of the German Government in 1917. The present membership consists of engineering societies, industrial associations and government ministries, and in addition there are 700 firms who are contributing members. The work of the Normenausschuss deals only with those subjects which concern two or more industries or branches of industry.

It is remarkable that the national standardization movement in Germany should have been so thoroughly organized and that so much work should have been accomplished in four years. 144 approved standards sheets have been issued and over 500 others have been so far developed that they have been published in tentative form. The standards are issued under the general designation of German Industrial Standards (Deutsche Industrie Normen, usually contracted to the slogan "DINORM"). The Germans were the first of the national bodies to publish standards in loose-leaf form. The work is so divided as to make each sheet as nearly independent as possible. Firms purchase these sheets in quantity, issuing them directly to designers, draughtsmen and foremen for use as working drawings and data sheets. (This plan is now followed by the Austrian, Dutch, Swedish and Swiss bodies.) The sale of sheets amounts to about 100,000 monthly.

From almost the first the Normenausschuss has been a periodical publication dealing with standardization. Formerly it was a separate publication, but now it forms a section of "Der Betrieb," a journal dealing with the general question of production and efficiency engineering. The communications from the Normenausschuss (Mitteilungen) average about 16 quarto pages per issue and form a separate section in this journal which appears semi-monthly, and has a circulation of 8000 copies.

The organization provides an extensive information service on standardization work in Germany and other countries, which is available to the industries as well as to their working committees. This is along much the same lines as the information service which has been started by the American Engineering Standards Committee. In this connection it is interesting to note that in general the German and Japanese industries appear to study foreign developments much more closely than do those of other countries.

Organization and Methods of Work

The organization and methods of work are similar to those in other countries. Next to the American Engineering Standards Committee, the German organization is the most decentralized of the national standardizing bodies. There is a Main Committee composed of representatives of the various national organizations supporting the movement, and a smaller Executive Committee. The detailed technical work of each project is in the hands of a working committee which in Anglo-Saxon countries would be called a "sectional committee" i.e., a committee made up of representatives of all bodies interested in the particular subject in hand.

Proposals for new subjects for standardization must come from some responsible body. The industry concerned is consulted, generally by a conference of the various organizations interested, to determine whether it is the consensus of opinion that the work should go forward. In case it is decided to undertake the work, the conference designates the chairman of the working committee.

The central office digests the information available on the subject for the use of the working committee. When agreement is reached in the committee on the draft of a standard it goes to the central office for editorial work. There it is scrutinized to see whether it is consistent with other standards; whether points have been included which concern other working committees; whether the drawings and nomenclature are in approved form, etc. After this editorial checking the central office has the draft of the standard put into proof form. It is then reviewed by an official clearing house committee, which contains a representative from each major line of work being carried on by working committees. If any change in substance has been made, it goes back to the working committee. If no such change has been made, it is published in the Mitteilungen, the official publication of the Normenausschuss, as a tentative proposal. Upon recommendation of the working committee, the standard is mailed to the members of the Executive Committee with a supporting statement. With their approval it is then republished as an official proposal. Six weeks are allowed for criticism, when a standard is finally published unless additional important criticisms are received.

Work in Special Industries

The foregoing refers to the work of the Central Body only, which is limited to subjects common to two or more industries. In addition there are some fifteen organizations known as special industry committees, each of which deals with the standardization work peculiar to a single industry, such as shipbuilding, electrical, agricultural, automotive, elevator, locomotive, paper, textile, and woodworking.

These committees are closely affiliated with, but not strictly an organic part of, the central body. They are organized not by the Normenausschuss, but by one or more technical or trade associations concerned with the particular subject in hand. Standards formulated by the special industry committees are published by the organization responsible. In most cases the final standards are published in loose-leaf form modeled closely after that of the standards issued by the Normenausschuss itself. These standards are submitted to the Normenausschuss before publication, in order to keep them consistent with the regular series of German industrial standards.

The volume of work being carried out through these special industry committees appears to be at least as great as that under the direct control of the Central Body.

Characteristics of Continental Work

Looked at broadly, and with exceptions such as must always be made in general statements of the kind, the Continental countries are going much further into dimensional standardization than has been done in Anglo-Saxon countries. This includes interchangeability of supplies and of machine elements, the interworking of parts and of related apparatus made by different makers, and the interchangeability, so far as the use is concerned, of complete machines and apparatus. By far the greater part of the work of the Normenausschuss is dimensional, greater attention being paid to such matters as machine elements, screw-threads, bolts and nuts, standard diameters, and systems of limit gaging. The Anglo-Saxon mind takes more to matters having to do with purchase and contract, such as specifications for materials, and for performance of apparatus, methods of test, etc. The Normenausschuss itself has done very little of this type of work as yet, but it has been highly developed by some of the German special industry committees, for

example, in the electrical industry. Some of these special industry committees are very active in the elimination of types, sizes and grades of manufactured products, and a special word has been introduced for this type of work, "Typung."

There is a greater dependence, on the Continent, upon theoretical and fundamental considerations, the Anglo-Saxon temperament giving rise to a much larger degree of expediency in adjusting commerical considerations in the process of arriving at agreements.

German manufacturers will go farther in yielding apparent temporary commerical advantages for the sake of advancing their national industry as a whole than is the case in America or Great Britain. Three principal reasons for this are: the great economic pressure under which German industry is laboring; the mental trait of more readily acquiescing in decisions affecting national welfare; and the belief that an essential to the rehabilitation of German industry is the rebuilding and great enlargement of their export trade, for which the importance of standardization on national lines is more readily apparent than it is in domestic trade.

The Germans have not yet had their standards translated into foreign languages for use in export, as the British are doing, but they are now giving consideration to this question.

German System of "Preferred Numbers"

As typical examples of the German work, their system of "preferred numbers" and their standard series of handles may be mentioned. The first is a fundamental piece of work, founded on theoretical considerations and of the first importance. It is a simple system of numbers for use in all new standardization work, in which gradated numerical values are required, such as standard gradated diameters of pulleys, thicknesses of plates, or capacities of machines. The Germans believe that its use is going to lead to great economies in material, in reducing the number of sizes, ranges, etc., simplify the carrying of stocks, facilitate interchangeability. It may be shown theoretically that, under average conditions, a given number of standard sizes laid out according to these numbers, will be better fitted to any series of jobs taken at random, than would be the same number of sizes laid out in any other way, and this with a minimum of material.

The standard handles furnish a typical example of German love of thoroughness of detail. There are two shapes, each adapted to a particular method of use, and there is a series of sizes for each shape. The profiles have been worked out with the most extreme care, an efficiency engineer having been employed to make time-motion studies to determine the exact profile that would insure the greatest accuracy in operaton with the minimum fatigue of the workman's hand. It is felt that by doing a thorough job once for all, different industries and firms will be saved from doing the same thing over and over, but always less well, and that at the same time interchangeability is introduced.

Industrial Significance

The standardization movement in Germany is particularly significant, since Germany is one of the three leading industrial countries. The industries of Austria, Holland, Sweden, and Switzerland, are so intimately related to those of Germany on account of geographical and other relationships that they are necessarily affected very largely by developments in Germany.

It appears that the work is being woven very intimately into the industrial fabric. The very large number of standards purchased by the industry, and the fact that the central organization has 5000 firms which are coöperating members, are a sufficient indication of this.

There seems to be a striking analogy between the present standardization movement in Germany, and the research movement developed there a generation ago. Whatever estimate one may place upon the role it played in German industries generally, everyone agrees that research was fundamental in the development of their great chemical industries. The role which the Germans are expecting standardization to play in all their industries would be not unlike the role which research has played in their chemical work.

A copy of a report on this subject, which was rendered to the American Engineering Standards Committee by its Secretary, will be sent upon request.

First Annual Report of the Federal Power Commission

Power developments of the past year, as shown in the first annual report of the Federal Power Commission, include a large number of projects on which, notwithstanding the industrial depression and the uncertain financial situation, construction work has already started, under license issued by the Commission, and indicate that the production and use of hydroelectric power in the United States is destined to be an outstanding industrial fact of the next twenty-five years.

Between 1910 and 1920 there was comparatively little waterpower development on the public domain or on navigable streams due to the fact that the legislation then on the statute books was, because of its limitations, considered unworkable. In the sixteen months following the passage of the Federal Water Power Act of 1920 there were filed with the Commission 185 applications for preliminary permit and 85 applications for license to develop waterpower, aggregating totals of 11,060,000 primary and 5,766,000 secondary horsepower or 16,826,000 horsepower of estimated installation. This is twice the water horsepower which has been developed in the United States to date and from five to six times greater than the aggregate of all applications filed with the Federal Government during the preceding 15 years.

Up to November 1, final action has been taken on 89 applications, in which 27 preliminary permits and 31 licenses were authorized, involving 1,415,600 primary and 2,627,000 installed horsepower. Construction is now under way on the following licensed projects.

	Primary horsepower	Installed horsepower
Henry Ford & Son, Inc., Hudson River, N. Y.	3,640	8,100
Niagara Falls Power Co., Niagara River, N. Y.	341,500	572,230
Southern California Edison Co., Big Creek, Cal.	165,000	546,000
Alabama Power Co., Coosa River, Ala.	21,760	110,000
Snow Mountain Power & Water Co., Eel River, Cal.	9,500	16,670
Western States Gas & Electric Co., American River, Cal.	6,400	6,400
Wisconsin-Minnesota Light & Power Co., Chippewa River, Wis. (Preliminary construction only)	10,000	20,000
Total	557,800	1,279,400

Much time and care has been devoted during the year to compilation of the rules and regulations governing administration of the Federal Water Power Act. The Commission's serious need at present is for Congressional authorization permitting the use of its appropriations in employment of personnel sufficient to make up a small organization of trained and experienced men capable of meeting intelligently the important and perplexing engineering and economic problems which are constantly arising and upon the correct solution of which will depend the value of Federal legislation and, in no small degree, the future of the electric-power industry.

A.S.M.E. Transactions Index to be Published

For the past forty-three years valuable information has been accumulating in the Transactions of The American Society of Mechanical Engineers. The Publication Committe now plan to render this material available by the publication of an index which will include the first forty-two volumes. The index, however, will be published solely on a subscription basis and those who desire to have this valuable means of reaching the important information included in the A.S.M.E. Transactions should write at once to the Secretary indicating their desire to have a copy printed for them. The book will be bound in morocco to conform to the edition of Transactions. The exact price will depend upon the number ordered and announcement of it will be made upon the closing of the subscription list. This offer will be announced only through the columns of MECHANICAL ENGINEERING and the *A.S.M.E. News*. An order card will be included in volume forty-two of Transactions which will be mailed to the membership early in March. The subscription list will be closed on April 15 and if the number of orders is sufficient, work will be started at once on the preparation of the book.

NEWS OF OTHER SOCIETIES

American Institute of Chemical Engineers

The fourteenth annual meeting of the American Institute of Chemical Engineers, held at Baltimore, Md., Dec. 6–9, 1921, was devoted primarily to the subject of gas warfare and chemical preparedness. A symposium on chemical engineering and national defense, continued from the first to the third day of the convention, was opened by an address by President David Wesson and included papers pointing out the humane aspects of gas warfare and reviewing the capacity for the production of chlorine in the United States, its uses, storage, and transportation.

At other sessions of the convention a survey of the lime industry was presented; Professor Cavalier, of France, exchange professor at Johns Hopkins University, read a paper on the Development of the Chemical Laboratories in France; glass as a material for chemical use was discussed; and the difficulties encountered in attempting to utilize low pressure steam after compression in evaporators were pointed out.

At a joint meeting with the Maryland Section of the American Chemical Society at Johns Hopkins University, a paper dealing with the development of a catalyzer by means of which carbon monoxide can be oxidized at room temperature to carbon dioxide was presented, and applications of ultra violet light described.

A number of excursions were held during the meeting, the most popular of which was an all-day visit to Edgewood Arsenal, where the entire morning was spent in inspection of the large installations of Nelson chlorine and caustic cells, the multiple effect evaporators, the gas-mask factory and the extensive research laboratories.

In the afternoon there was a field demonstration of various forms of gas warfare. In connection with the inspection of the Arsenal an address on chemical warfare was delivered by Brig-Gen. Amos A. Fries.

At the business meeting on the first day of the convention the council of the Institute reported an amendment to the constitution providing for student chapters similar to those affiliated with other engineering societies and another resolution providing for the organization of local sections of the Institute.

Arthur D. Little, as chairman of the Committee on Chemical Engineering Education, presented a study of the courses in chemical engineering offered at all the technical schools and universities of the United States and it was voted to call a meeting of representatives of institutions offering courses in chemical engineering for the purpose of securing greater uniformity in such courses.

L. W. Wallace, executive secretary of the F.A.E.S., addressed the business session on the most important activities of the Federation, of which the Institute is a member society.

American Society of Refrigerating Engineers

The three-day annual meeting of The American Society of Refrigerating Engineers, held in New York, Dec. 5–7, 1921, included six technical sessions. At the first of these the subjects considered were the artificial production of natural ice, the use of automatic temperature-controlled expansion valves, and small insulated containers, the speakers on these respective subjects being R. H. Hemphill, Charleston, S. C., G. A. Wegner, Rochester, N. Y., and M. E. Pennington, New York, N. Y.

In three papers presented at an evening session on December 5, C. S. Cragoe, of the U. S. Bureau of Standards, outlined the present status of the measurements of superheated ammonia at the Bureau, and discussed specific volumes of superheated ammonia vapor and of ethyl chloride, liquid and vapor. G. F. O'Conner, also of the Bureau, was co-author with Mr. Cragoe of the last paper. It was announced that the Bureau of Standards would soon be in a position to issue tables on superheated ammonia. A paper entitled Coördinating Technical Knowledge and Practical Conditions in Refrigerating Plants, by Peter Neff, Canton, Ohio, was also presented at this session.

Ammonia compression was the main topic at the two sessions held on December 6. The construction and operation of three types of compressors were described by F. L. Fairbanks, of Boston. These types were a slow-speed steam-driven compressor with a booster set, a motor-driven compound compressor and a uniflow steam-engine-driven compound compressor with feather valves. George A. Horne, New York City, spoke on the subject of compound ammonia compression, describing one of the most complete tests for a compound compressor which had even been conducted. Synchronous and starterless induction motors for ammonia compressors were discussed, and a paper on cooling systems of buildings presented.

Among the papers presented at the session on the closing day of the meeting was one by H. J. Macintire, of Urbana, Ill., dealing with research work in refrigeration conducted at the University of Illinois; the presentation of a total-heat diagram for carbon dioxide, showing the effect of pressure, also by Mr. Macintire; a description of a new thermal testing plate for conduction and surface transmission, by A. J. Wood, State College, Pa.; and a discussion of the theory and practice of spray nozzle cooling, by B. H. Coffey and G. S. Dauphinee, both of New York City.

An excursion to the North Moore Street Power Plant of the Merchants Refrigerating Co. of New York was held on the second day of the convention.

Items of business at the opening session included a discussion of the Mechanical Refrigeration Safety Code.

American Petroleum Institute

The American Petroleum Institute held its second annual meeting in Chicago, Ill., December 6–8, 1921. In his opening address, Thomas A. O'Donnell, president of the Institute, referring to the adequacy of the world's supply of petroleum, gave as his opinion that if unrestricted opportunity for development is afforded to those engaged in the industry, the supply of petroleum products will be adequate for all requirements for many generations to come.

Walter C. Teagle, president of the Standard Oil Company of New Jersey, believed that in adequate storage facilities lies the chief requisite for securing a better balance between production and consumption of petroleum products and the resulting avoidance of the serious price fluctuations which the industry has seen during the current year.

The technical sessions of the Institute were devoted almost exclusively to a discussion of the automotive fuel problem. Dr. Van H. Manning, director of research of the Institute, presented a quantitative survey of the petroleum industry from the standpoint of motor fuel, and Edward S. Jordan, president of the Jordan Motor Car Company, a similar survey of the automotive industry. These speakers pointed out the effect of automotive fuel requirements on the petroleum industry and upon the future development of motor cars.

N. A. C. Smith, petroleum chemist, of the Bureau of Mines, discussed the volatility of motor fuel as marketed in the United States, and stated that he believed that eventually we would have as nearly uniform gasoline as is commercially possible.

The motor fuel problem from the standpoint of the automotive engineer was discussed by O. C. Berry, chief of the Wheeler-Schebler Carburetor Company, who stated that the present grade of fuel can be used with fair success in the laboratory and urged that refiners make no further reduction in volatility until the automotive industry is prepared to meet it.

F. C. Mock, research engineer, Stromberg Motor Devices Company, discussing the effect on motor economy of volatility changes in the fuel, urged as great a uniformity as possible in motor fuel, and the adoption of a recognized standard to which motor fuels should conform.

Greater uniformity in motor fuel was the chief point brought out in all the discussions. The adoption of uniform specifications was urged and some speakers suggested the appointment or establishing of a referee laboratory to which all fuel questions arising between automotive engineers and refiners could be referred.

National Society for Vocational Education

The National Society for Vocational Education, which as the National Society for the Promotion of Industrial Education, was the "first national organization to promote interest in publicly supported vocational education," held its fifteenth annual convention in Kansas City, Mo., Jan. 5, 6, and 7, 1922.

The larger part of the program was given over to sectional meetings on various phases of vocational education. These covered agricultural, commercial, home-making, and industrial education,

part-time and continuation schools, teacher training, training in industry, and industrial rehabilitation.

The work being done by other national associations engaged in vocational education was told by representatives of such organizations at one of the general meetings.

A joint meeting of the Industrial Education Section and the Training in Industry Section considered the subject of coöperation between public and private training agencies, the present situation was outlined, its causes discussed, and ways and means of dealing with it suggested.

Other sessions of the Industrial Education Section gave special attention to the day industrial and trade schools, and their relation to industry.

Problems of the part-time and continuation schools were studied at several sessions and their value as economic, industrial and social factors brought out. What is being done in industrial rehabilitation formed the topic of several sessions.

Among educational exhibits at the convention, of interest to all and of special value to teachers and supervisors in vocational work, were those showing building plans for vocational schools, vocational education material not published in book form, and the use of motion pictures in teaching shop processes.

LIBRARY NOTES AND BOOK REVIEWS

Library Book Loans

The Library Board has adopted rules authorizing the Director of the Library to lend to members of any Founder Society any duplicate books in the Library, subject to the following four rules:

1 Duplicate books may be lent to members of Founder Societies or of any other societies that contribute to maintain the Library

2 Books will be lent for twenty-eight days, including time in transit

3 Five cents a day will be charged for each book kept longer than twenty-eight days

4 Borrowers shall be responsible for books borrowed, and shall pay shipping and insurance charges from and to the Library.

The Library has several thousand volumes that can be lent under this authorization. These include a considerable number of text-books, reports, etc., of various dates. Periodicals are not included, as the cost of storing duplicate sets seems prohibitive and individual articles can be photoprinted at little expense. The collection is being increased regularly by the addition of any suitable duplicates received by the Library. Members are invited to present any books of permanent value for this purpose, which they can spare from their libraries. It is hoped that the collection may in time become adequate to meet the usual needs of members by providing any standard book needed for a short time.

No catalog has been published, although it is hoped that one may be, when the collection becomes extensive enough to warrant doing so. Until that time, the Director will be glad to receive requests and report as to whether the books are available or not.

The A.S.M.E. Issues Westinghouse Biography

The subscription edition of the Life of George Westinghouse was mailed early in January and the popular edition, published by Charles Scribner's Sons, was placed on sale on January 27. The subscription edition, which was sold to members of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers, appeared in two bindings, the half morocco and the buckram. This edition, in contents and form, is a worthy addition to the publications of the A.S.M.E.

Through the courtesy of some friends of Mr. Westinghouse, the plates for the book have been placed at the disposal of the Society, and, with the coöperation of Charles Scribner's Sons, a plan is being developed whereby the popular edition can be widely distributed.

The book is already attracting wide interest as a story of the life of a man preëminent among engineers.

The author of the book, Colonel Henry G. Prout, was an intimate friend of Mr. Westinghouse and in its fascinating record of a remarkable life, he has developed a great amount of material which is of value, not only in connection with the life of George Westinghouse, but as an inspiring revelation of the part the engineer must play in our present day civilization. A more complete review will appear in this section of the March issue of MECHANICAL ENGINEERING.

AUTOMOBILE AND AIRCRAFT ENGINES. By Arthur W. Judge. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. Cloth, 6 × 8 in., 642 pp., illus., tables, $9.50.

Presents, in as concise and elementary form as possible, an account of the theory of the lighter-fuel type of high-speed internal-combustion engine, and of the experimental results obtained from it. Intended especially for engineers and designers of automotive machinery. Nearly twice the size of its predecessor, the additions being chiefly experimental data obtained in recent years.

AUTOMOBILE ENGINEERING. Chicago, American Technical Society, 1920. 6 vols. Fabrikoid, 6×8 in., illus., $29.80.

A course of self-instruction and a book of reference covering the maintenance and operation of automobiles of all kinds. Information given is presented clearly and without mathematics, and is illustrated by many cuts and drawings. Earlier editions were entitled Cyclopedia of Automobile Engineering.

CANE SUGAR. By Noel Deerr. Second edition. Norman Rodger, London, 1921. Cloth, 7×10 in., 644 pp., plates, illus., 42s.

The author of this work, writing from long experience in the cane-sugar industry, acquired in the more important sugar-producing districts of the world, gives an account of the salient points of the industry, with a detailed treatment of its more important aspects. The botany, agriculture and pathology of the sugar cane, sugar-house practice and the control of the processes are given careful treatment. Many colored plates are included, and there are numerous lists of references and an extensive bibliography. This edition has been reset and enlarged.

COMPTEURS DE VAPEURS. By E. Hoehn. Ch. Béranger, Paris, 1921. Paper, 6×9 in., 34 pp., illus., 2 fr.

This pamphlet by the chief engineer of the Swiss association of boiler owners describes the theory and operation of ordinary and recording steam meters, with notes on the advantages and disadvantages of the different types.

COURS DE MECANIQUE RATIONELLE. By Louis Roy. Gauthier-Villars et Cie, Paris, 1921. Paper, 5×10 in., 259 pp.

This volume, with the author's previous book on graphic statics and strength of materials, forms a course of instruction in mechanics for students of engineering. The present work is intended for beginners and therefore is confined to the elements of mechanics, which it presents so that students will have the grounding necessary for the study of applied mechanics, general physics and electrical engineering.

ECONOMICS OF PETROLEUM. By Joseph E. Pogue. John Wiley & Sons, Inc., N. Y., 1921. Cloth, 6×9 in., 375 pp., plates, illus., $6.00.

The purpose of this book is to present the more important economic facts relating to petroleum, to interpret the changes that are taking place in the industry and to forecast the future trend of these changes. The book is intended for those engaged in the petroleum industry as engineers or producers, and for those engaged in industries dependent on petroleum products, and contains useful information on our resources, the trend of development, production and refining, transportation, prices, trend of consumption, and similar topics.

Die Steuerungen der Dampfmaschinen. By Heinrich Dubbel. Second edition. Julius Springer, Berlin, 1921. Cloth, 6 × 9 in., 384 pp., illus., 69 marks.

This is a treatise on the theory and design of valve and reversing gears for reciprocating steam engines, for the use of designers. The discussion is confined chiefly to the modern forms that have been introduced to meet the demands of high steam pressures and increased speeds, and the competition of steam turbines and gas engines. Matter which is only of historical interest has been omitted, but full attention is given to gearing of the types which have proved best fitted to modern requirements. The discussion of reversing gears includes material on locomotives, rolling-mill and hoisting engines.

Invention the Master-Key to Progress. By Bradley A. Fiske. Dutton & Co., New York, 1921. Cloth, 6 × 8 in., 356 pp., illus., $4.

The thesis of this author is that invention, acting through literature, science, art, war and the other activities of men, has initiated all creative human progress; and his book is an interesting account of what inventors have accomplished through the ages, and a forecast of what may be done in the future, if the art of invention is properly fostered.

Machine Drawing. By Carl L. Svensen. D. Van Nostrand Co., New York, 1921. Cloth, 6 × 9 in., 214 pp., illus., $2.25.

This textbook is written for students who have had previous instruction in mechanical drawing and is intended to develop an understanding of the relation of machine drawing to engineering. It includes a complete treatment of working drawings, drafting-room practice, a chapter on the principles and practice of dimensioning, a study of the common machine details, jigs and fixtures, and a large collection of problems.

Material Handling Cyclopedia. Compiled and edited by Roy V. Wright, John G. Little and Robert C. Augur. Simmons-Boardman Publishing Co., N. Y., 1921. Cloth, 9×12 in., 846 pp., illus., $10.

Designed to present comprehensively definitions, descriptions, illustrations, applications and methods of operation of industrial devices for handling materials. Covers hoisting machinery, package conveyors, loose-material conveyors, elevators, trackless transportation, industrial rail transportation and handling systems. Each section has been prepared by a specialist.

Mechanical Handling of Goods. By C. H. Woodfield. Sir Isaac Pitman & Sons, Ltd., London, 1921. (Technical primers.) Cloth, 4 × 6 in., 116 pp., illus., $0.85.

The object of this book is to set forth sufficient information upon the handling of goods and material to enable the uninitiated to understand the methods and equipment employed and appreciate the economic possibilities of dealing with goods by mechanical methods.

Mechanical Principles of the Aeroplane. By S. Brodetsky. The Macmillan Co., New York, 1921. Cloth, 6 × 10 in., 272 pp., illus., $7.

Section one, Motion in Air, contains a brief statement of the general theory of resisted motion, a discussion of the dynamics of a body moving in air and the theory of steady flight, which indicates what it is that aerodynamical research must investigate. In section two, Dynamics of Air, the hydrodynamical method of attacking the problem is set forth, and in section three, Aeroplane Motion, theoretical and experimental results are applied to the steady flight and stability of aeroplanes, followed by an account of the motion of a disturbed aeroplane. The treatment is confined to the mathematical parts of these problems.

Memoires Sur L'Electromagnetisme et L'Electrodynamique. By André-Marie Ampere. Paper, 4 × 7 in., 110 pp., illus., 3 fr.

The two classic memoirs in this little book are that in which Ampère described his experiments upon the action exerted on an electric current by another current or a magnet, and the one giving the results of his study of the formula expressing the attraction and repulsion between two infinitely small elements of two conductors. They are here reprinted from the best text, in attractive form.

La Physique Theorique Nouvelle. By Julien Pacotte. Gauthier-Villars et Cie, Paris, 1921. Paper, 182 pp., 6 × 10 in., 12 fr.

The new physics in question had its origin in Lorentz's electrodynamics, which is the definitive form of Maxwell's theory; its most advanced theories are due to Einstein; it has to do with relativity, with the energy equivalent of two masses of matter, with atoms of energy. The author presents a historical, critical, non-mathematical account of the theories that underlie modern ideas, suitable as an introduction to the subject.

Practical Least Squares. By Ora Miner Leland. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 237 pp., $3.00.

This textbook is based on the course given to students of civil engineering at Cornell University and is designed particularly for use in short courses of instruction and by engineers and scientists in connection with their private practice. It will not replace more elaborate treatises, but the author hopes it will introduce the student directly to the simpler methods of solving the ordinary problems in adjustment.

Power's Practical Refrigeration. Compiled by the editorial staff of *Power*. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Fabrikoid, 6 × 8 in., 283 pp., illus., tables, $2.

A volume dealing with the practice of refrigeration, but also including the laws governing its production. Chiefly made up of articles that have appeared in *Power* and have proven of particular value to those operating refrigerating plants.

Profit Sharing by American Employers. A report of the Profit Sharing Department of the National Civic Federation. Dutton & Co., New York, 1921. Cloth, 5 × 8 in., 416 pp., $8.

The first edition of this book, published in 1916 by The National Civic Federation, was based on analyses of more than two hundred plans for profit-sharing in use in this country. It was intended to present testimony, from managers of manufacturing establishments, concerning the success and failure of such plans. This edition is practically a new book, as much of the former material has been omitted and numerous additions have been made, enlarging the book and bringing it up to 1919.

The Psychology of Industry. By James Drever. Dutton & Co., New York, 1921. Cloth, 5 × 8 in., 148 pp., $2.50.

Dr. Drever discusses such topics as the intelligence and vocational fitness of the worker, scientific mental engineering, the factors determining efficiency of work, fatigue, economy of movement, advertising and salesmanship. Upon these and similar matters he sets forth what has been done by the psychologist, in language understandable by the ordinary man. A special effort is made to adhere to the psychological point of view and to emphasize principles rather than details of results.

Radio Questions and Answers. By Arthur R. Nilson. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Boards, 5 × 7 in., 86 pp., illus., $1.

A quiz compend for those preparing for examination. Treats of theory, apparatus, laws and regulations, etc.

Railroad Shop Practice. By Frank A. Stanley. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 331 pp., illus., $4.

The purpose of this book is to show typical methods and appliances as adapted to the work of various railroad repair shops, large, medium and small, situated in different parts of the United States. Much of the material presented has been taken from the articles by the author and others in technical journals, but a considerable amount is new.

Railway-Signaling. By Everett Edgar King. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 371 pp., illus., diagrams, $4.

The purpose of this book is to collect what is already in common practice in railway signaling and to present it in text-book form, suitable for use by those beginning the study of this subject. The volume discusses signal indications, interlocking, block signaling, signal mechanisms and highway-crossing signals.

STEAM BOILERS. By Terrell Croft. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 8 in., 412 pp., illus., $4.

This book has been compiled for men of little schooling who wish to inform themselves about the construction and operation of steam boilers, especially those preparing for examinations for engineers' licenses. It treats of the functions, history and modern types of boilers, boiler construction, accessories, steam generation, superheating, fuels, settings, furnaces, feedwaters, boiler-room equipment, inspection and management, in clear, simple and easily read language.

STEAM-ENGINE VALVES AND VALVE GEARS. By E. L. Ahrons. Sir Issac Pitman & Sons, Ltd., London, 1921. (Technical primers.) Cloth, 4 × 6 in., 112 pp., illus., $0.85.

This primer gives, in an elementary form, a concise description of the usual forms of steam-engine valves and valve gears, and an explanation of their action.

TEMPERATURE INDICATING AND CONTROLLING SYSTEMS. By Franklin D. Jones. First edition. Industrial Press, New York, 1921. Paper, 6 × 9 in., 59 pp., illus., $0.50.

A general review of the application of thermoelectric pyrometers to the heat-treatment of steel parts. The methods and apparatus used in various plants to indicate, control and record temperature are described and illustrated.

THEORIE UND WIRKLICHKEIT BEI TRIEBWERKEN UND BREMSEN. By St. Löffler. R. Oldenbourg, München und Berlin, 1919. Paper, 6 × 9 in., 94 pp., 5.50 M.

This small volume contains the author's answers to various criticisms of the theory advanced by him in his earlier volume entitled Mechanische Triebwerke und Bremsen. The various objections to the author's former assertions are met and answered in detail.

THERMODYNAMICS. By J. E. Emsweiler. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 266 pp., diagrams, $3.

An attempt to present the subject progressively so that the reader may easily recognize the relation of each new demonstration to the whole. For this purpose the order of presentation is changed from that usually employed. Steam is placed first, followed by vapor refrigeration, after which the permanent gases, mixtures and air-heat engines are studied. Formal discussion of the laws of thermodynamics and the kinetic theory of gases is postponed until the close of the book

DER 1000 PS FLUGMOTOR. By Edmund Rumpler. R. Oldenbourg, München, 1921. Cloth, 10 × 21 in., 63 pp., plates, 50 M.

Present-day aviation engines are, according to this monograph, only lighter automobile engines, constructed in almost every case by automobile engineers without special knowledge of the problems of flight. The engine here described is designed to meet the peculiar conditions of flight and overcome the deficiencies of the engines hitherto used. The text and drawings illustrate a 1000-hp. engine, a combination of the radial and horizontal arrangement of cylinders, having four sets of seven radial cylinders.

TIDAL POWER. By A. M. A. Struben. Sir Isaac Pitman & Sons, Ltd., London, 1921. Boards, 4 × 6 in., 115 pp., diagrams, $0.85.

This little book is intended to stimulate interest in a field that is likely to attract attention in the near future. It indicates some of the possibilities, the difficulties that are found and the systems that have been proposed.

TIME STUDY AND JOB ANALYSIS. By William O. Lichtner. Ronald Press Co., New York, 1921. Cloth, 6 × 9 in., 397 pp., illus., $6.

The author attempts to explain the practical application of these methods in simple, non-technical terms, as might be done in a series of conferences with an executive charged with the responsibility of decision. The book first presents a general review of the principles of job standardization and their application to time study and job analysis. The organization of a staff to carry out the work is then described in detail. This is followed by a detailed description of the technique of the subject, and the book closes with a consideration of the relation of job standardization to industrial problems.

TRAITE DE BALISTIQUE EXTERIEURE. By P. Charbonnier. Volume 1. Gauthier-Villars et Cie, Paris, 1921. Paper, 6 × 10 in., 637 pp., diagrams, 7 francs.

This is the first of the six volumes in which it is proposed to publish Charbonnier's treatise on external ballistics to which the Poncelet prize was awarded by the French Institute in 1919. The author has planned a treatise, embracing everything relating to the science, methodically classified and treated in detail, suited to the needs of students of its theory and of practical artillerymen. His book therefore is a summary of our knowledge at the close of the great war.

The present volume, intended as an introduction to the subject, is divided into two parts. The first is a discussion of the three limiting cases of the ballistic problem, motion in a vacuum and rectilinear motion and vertical motion in a resisting medium. The second considers the general theorems of ballistics, and includes the general properties of atmospheric trajectories and the application of analysis to the ballistic problem.

TURBINES. By A. E. Tompkins. Third edition, revised. The Macmillan Co., New York, 1921. Cloth, 5 × 8 in., 180 pp., illus., $2.50.

Describes, in simple, non-mathematical fashion, good modern practice in the construction and working arrangement of water turbines, turbine pumps and steam turbines. The book will be useful to students and to men engaged in fitting and repairing turbines.

UNION ENGINEERING HANDBOOK; PUMPING MACHINERY, AIR COMPRESSORS, CONDENSERS. Compiled by E. P. Ordway. First edition. Union Steam Pump Co., Battle Creek, Mich., 1921. Cloth, 5 × 9 in., 442 pp., illus., $2.

Intended for engineers, architects and others interested in air compressors, condensers and steam, centrifugal, power and vacuum pumps. Contains the engineering information and data usually desired in calculating the problems encountered in handling these machines, with special information on the products of the company which publishes the book.

VORRICHTUNGEN IM MASCHINENBAU NEBST ANWENDUNGSBEISPIELEN. By Otto Lich. Julius Springer, Berlin, 1921. Cloth, 6 × 9 in., 507 pp., illus., diagrams, 120 m.

A detailed study of clamps, fixtures and jigs for machine tools and of their application to increase output. All the customary operations, boring, slotting, planing, milling, forging, hardening, etc., are considered. There is also a section on the savings obtainable by such attachments and one on maintenance and repair. The book is intended for machine builders, and for operators who wish to increase the efficiency of existing equipment. The author presents his book as a contribution toward the reconstruction of the German metal industries, which he believes will be possible only through the greatest possible economy of time and of labor.

THE WORKING OF STEEL. By Fred H. Colvin and K. A. Juthe. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 245 pp., illus., $4.

The authors have collected, from their own experience and that of others, information upon the most approved methods of working the various kinds of steel in use today. These include low-carbon, high-carbon and alloy steels of various kinds and from a variety of industries. The book discusses the chemical and physical properties of steels, forging, annealing, case-hardening, heat treatment and hardening.

Index to Volume 43 of Mechanical Engineering

An index to Volume 43 of MECHANICAL ENGINEERING is now in the course of preparation, and, it is expected, will be issued the latter part of February. A copy of this index will be sent to each member of the Society or subscriber who sends in a written request therefore. In order that no more copies than are necessary to supply the demand may be printed, requests for copies should be received at headquarters not later than February 15.

THE ENGINEERING INDEX

(Registered U. S. Patent Office and Canadian Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCOUNTING

Power Plants. Power-Plant Accounts, Wilfred A. Miller. Power, vol. 54, nos. 16, 17, 18, 19, 20, 21, 22, 23, 24 and 25, Oct. 18, 25, Nov. 1, 8, 15, 22, 29, Dec. 6, 13 and 20, 1921, pp. 596–599, 636–638, 680–684, 719–723, 769–772, 805–809, 848–852, 891–894, 934–936 and 979–980, 59 figs. Oct. 18: How to record indirect expenses. Oct. 25: Interest on borrowed money, profit and related subjects. Nov. 1: Considerations in buying equipment; meaning of depreciation. Nov. 8: Power plant as manufacturing department. Nov. 15: "Income" and "profit and loss" accounts. Nov. 22: The "surplus" account. Nov. 29: Debit and credit; the cash account. Dec. 6: Closing ledger accounts. Dec. 13: Investment account and reserve for depreciation and obsolescence. Dec. 25: Scrapping equipment. (Continuation of serial.)

AERODYNAMICS

Standardization. Standardization and Aerodynamics, L. Prandtl. Aerial Age Weekly, vol. 14, no. 4, Oct. 3, 1921, pp. 79–80. Discusses wind tunnels, size of models and air velocity, placing of models, drift coefficients and the results.

AIR

Joule-Thomson Effect. The Joule-Thomson Effect for Air, Frederick G. Keyes. Jl. Am. Chem. Soc., vol. 43, no. 7, July 1921, pp. 1452–1470, 2 figs. Discusses Hoxton's investigation; expansion coefficients of a gas; absolute ice-point temperature; Joly constant-volume specific-heat values for air.

AIR COMPRESSORS

Combination Hoist and. New Combination Hoist and Air Compressor. Eng. & Contracting, vol. 46, no. 21, Nov. 23, 1921, p. 483, 1 fig. Designed especially for bridge and elevated-tank erection, and brought out by Novo Engine Co., Lansing, Mich. Can also be used for trench work.

German. Air Compressors and German Aviation (Les compresseurs d'air dans l'aviation Allemande), G. Lehr. La Technique Moderne, vol. 13, no. 9, Sept. 1921, pp. 369–376, 11 figs. Discusses compressors by Schwade, Brown-Boveri, A. E. G., Siemens-Schueckert; also control systems of air supply for combustion.

Regulation. The Regulation of Air Compressors. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 918–921, 11 figs. Discusses various arrangements used to control amount of air delivered by compressor.

AIR CONDITIONING

Chemical Processes. Notes on the Relation of Atmospheric Conditions to Chemical Processes, A. E. Stacey. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 777–781, 3 figs. Gives a few typical examples of need of air conditioning in chemical industry.

AIRPLANE ENGINES

Bristol Jupiter. Tests of the 450 Hp. Bristol Jupiter Engine. Aviation, vol. 11, no. 24, Dec. 12, 1921, pp. 685–686, 2 figs. An air-cooled radial aero engine, which has passed the tests of the British Air Ministry.

Carburetors. See CARBURETORS.

Cylinders. Preliminary Calculation of Cylinder Dimensions for Aircraft Engines, Otto Schwager. Aerial Age Weekly, vol. 14, no. 8, Oct. 31, 1921, pp. 179–180 and 187. Method described depends on air requirement of fuel. Gives examples for water-cooled, air-cooled and rotary engines. Translated from Zeit. fur F. & M., Dec. 31, 1920.

Fuel. The Problem of Fuel for Aviation Engines, Aerial Age Weekly, vol. 14, no. 1, Sept. 12, 1921, pp. 8–11 and 22–23, 6 figs. Technical note of Nat. Advisory Committee for Aeronautics. Discusses composition, quantity available, price per heat unit, stocks of fuel at aerial ports, preparation of fuel mixtures, carburetor function, etc. Lecture given by Prof. Kutzbach.

Fuel Pump. The Sylphon Fuel Pump for Liberty "12" and Wright Model "H" Engines. Air Service Information Circular, vol. 3, no. 281, Oct. 15, 1921, 8 pp., 4 figs. Designed to fill need for an engine-driven fuel pump in order to obviate use of air pressure where sufficient gravity head is not available. Description and rules for dissembly.

Gear Pump. Performance of a Vane-Driven Gear Pump, R. H. Heald. Aerial Age, vol. 14, no. 4, Oct. 3, 1921, pp. 81–83 and 90, 8 figs. Gives results of tests with pumping unit driven by a wind wheel in air stream during flight, for pumping gasoline to tank in upper wing from which it flows by gravity.

Radiators. Cooling System Test of the Curtiss JN-6 with Packard 1A-744 Engine Equipped with Side Radiators. Air Service Information Circular, vol. 3, no. 294, Oct. 20, 1921, 12 pp. 8 figs. Result of test to determine effectiveness of side radiators.

Getting Airplane Details on a Manufacturing Basis. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 886–887, 7 figs. Economical methods in radiator construction. Soldering tube ends in multiple. Punches and dies for fittings made adjustable by insertion of loose pieces.

AIRPLANE PROPELLERS

Tandem. The Question of Tandem Propellers, A. Lapresle. Aviation, vol. 11, no. 24, Dec. 12, 1921, pp. 679–680, 3 figs. Gives results of experiments carried out by Eiffel; tandem propellers must turn in opposite directions if the rear propeller is to have a satisfactory efficiency. Translated from L'Aerophile.

AIRPLANES

Aerofoils. The Influence of Aerofoil Dimensions on Speed (Ueber den Einfluss der Flügelabmessungen auf die Fluggeschwindigkeit), E. Lupberger. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 21, Nov. 15, 1921, pp. 316–318, 2 figs. Concludes that all efforts to increase difference between flying and landing speed by changing surface dimensions or by use of divided planes have little prospect of practical success.

Blériot Passenger. The New Blériot-Aeronautique Airplanes (Les nouveaux avions de "Blériot-Aeronautique"). L'Aeronautique, vol. 3, no. 30, Nov. 1921, pp. 436–437, 5 figs. Describes Spad 34, 38 and 45, the latter transporting 17 passengers and crew of 3 and having four 275-hp. Hispano-Swiss engines, marine type.

Brakes. Electro-Magnetic Brakes for Aeroplanes. Aerial Age Weekly, vol. 14, no. 3, Sept. 26, 1921, pp. 57 and 54. Describes the Gernsback device, an electromagnetic attracter on the landing stage which brings airplane to a stop at a definite point and within short range. From "Sea, Land and Air."

Commercial. The Barnhart Twin No. 15 "Wampus-Kat." Aerial Age Weekly, vol. 13, no. 26, Sept. 5, 1921, pp. 615–617, 4 figs. Commercial airplane built by C. R. Little Aircraft Works, Pasadena, Cal. Report of test pilot; describes principal features and gives specifications.

Curtiss Navy Racer. The Navy Racer Which Won the Pulitzer Trophy, Herbert Chase. Automotive Industries, vol. 45, no. 21, Nov. 24, 1921, pp. 1015–1016, 2 figs. Designed and built complete in Curtiss plant. Gives specifications and equipment; average speed attained 176.7 m.p.h.; 12-cylinder V-type engine; 405 b.hp. at 2,000 r.p.m.

DH-4 Corps Observation. Performance Test of DH-4 with 400 Hp. Liberty "12" Engine, Equipped as Two-Seater Corps Observation Airplane. Air Service Information Circular, vol. 3, no. 287, Oct. 1, 1921, 7 pp., 5 figs. Summary of test results; distribution of weights; description of airplane and power plant.

Fokker Monoplane. A Dutch Passenger-Carrying Monoplane, P. M. Heldt. Automotive Industries, vol. 45, no. 23, Dec. 8, 1921, pp. 1113–1114, 2 figs. Describes a Fokker carrying six passengers and fuel for 500 miles; 200-hp. B.M.W. engine.

Official Performance Test of Fokker Monoplane D-VIII Equipped with 110 Hp. Oberursel Engine. Air Service Information Circular, vol. 3, no. 288, Oct. 1, 1921, 8 pp., 5 figs. Gives summary of results of test, pilot's observations, and description of airplane and power plant.

Improving Performance. Means for Improving Airplane Performance, Harlan D. Fowler. Aviation, vol. 11, no. 23, Dec. 5, 1921, pp. 652–655, 14 figs. Discusses aerofoils, combining high speed with large load, variable area, etc.

Load Factors. Effect of Variation in Load Factor on Structural Weight of Wings, R. A. Miller. Aerial Age Weekly, vol. 14, no. 8, Oct. 31, 1921, pp. 177–178, 1 fig. Concludes that area of spars varies directly with load factor, area of struts varies with load factor and increases at slightly smaller rate than load factor, etc.

Martin Bomber. Official Performance Test of Martin Bomber N.B.S.-1 Equipped with Two 400 Hp. Liberty "12" Engines. Air Service Information Circular, vol. 3, no. 290, Oct. 1, 1921, 10 pp., 6 figs. Summary of test results; discussion of flight with one engine; pilot's observations; description of airplane and power plant.

Messenger. Performance Test of Messenger Airplane Equipped with 3-Cylinder 60 H.p. Lawrence Engine. Air Service Information Circular, vol. 3, no. 280, Oct. 15, 1921, 7 pp., 5 figs. Summary of test results; description of airplane and power plant; and pilot's observation.

Multi-Engined. Multi-Engined Commercial Airplanes, Donald W. McIlhinev. Aviation, vol. 11, no. 18, Oct. 31, 1921, pp. 506–507. Gives table of principal data of 44 such airplanes, and discusses main points.

Orenco. The Orenco Type F-4 Five-Place Tourister. Aerial Age Weekly, vol. 14, no. 11, Nov. 21, 1921, pp. 246–248, 4 figs. Built by Ordnance Eng. Corp. Wright E-2 engine; 200 hp. at 1800 r.p.m. Specifications and description

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NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U.S.)
Ventilating (Vent.)
Western (West)

Racing. Airplane Racing and Racing Machines (Flugzeug-Rennen und Rennflugzeuge), Fr. Wm. Seekatz. Motorwagen, vol. 24, no. 3, Jan. 31, 1921, pp. 48–53, 10 figs. Presents table and chart showing results of Gordon Bennett races from 1909 to 1920. Notes on French and American racers, the Verville-Packard biplane, the Dayton-Wright monoplane, and the Curtiss-Cox monoplane.

Soaring. The Soaring Airplane (Das Segelflugzeug der akademischen Fliegergruppe der technischen Hochschule Hannover), W. Blume. Zeit. fur Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 21, Nov. 15, 1921, pp. 313–316, 9 figs. Details of monoplane designed by G. Madelung and constructed under his supervision by student group of Hannover Technical Acad.

Speed Meters. N.A.C.A. Recording Air Speed Meter, F. H. Norton. Aerial Age Weekly, vol. 14, no. 7, Oct. 24, 1921, pp. 151 and 154, 7 figs. Describes new type designed by technical staff of Nat. Advisory Committee for Aeronautics, consisting of a tight metal diaphragm of high natural period which is acted upon by the pressure difference of a pilot-static head.

Staggering of Biplane. The Effects of Staggering a Biplane, F. H. Norton. Aerial Age Weekly, vol. 14, no. 5, Oct. 10, 1921, pp. 103–104, 5 figs. The lift, drag and center of pressure travel are determined for a biplane with a stagger varying from —100 per cent to +100 per cent.

Static Test. Report of Static Test on Engineering Division Messenger Airplane. Air Service Information Circular, vol. 3, no. 270, Oct. 1, 1921, 15 pp. 10 figs. Particulars of tests carried out at McCook Field, Dayton, Ohio, to determine strength of wings, ailerons, empennage, fuselage, and chassis.

Storage of Parts. Instructions for the Storage of Airplanes, Engines, Their Parts and Accessories. Air Service Information Circular, vol. 3, no. 256, July 15, 1921, 9 pp. Deals with storage of wooden airplane parts, airplane materials, engines, armament, equipment and propellers. Specifications covering requirements of Air Service for rust-preventing compound for protection against corrosion of aircraft engine.

Struts. Tests on Combined Loading of Wooden Struts. Air Service Information Circular, vol. 3, no. 276, Oct. 1, 1921, 11 pp., 5 figs. Results of investigation to determine whether test data obtained when a wooden strut is subjected to a column load and also to a side or lateral bending load verify formulas now in use.

Tests. Aerodynamical Report and Tests on the Eggleston Air Cell Giant Biplane. Aerial Age Weekly, vol. 14, no. 14, Dec. 12, 1921, pp. 323–324 and 326, 4 figs. Report of tests carried out at wind speed of 30 m.p.h. by Cox-Klemin Aircraft Corp., College Point, L. I.

Truss Ribs. Experimental Reinforced Plywood Truss Ribs, B. C. Boulton. Aerial Age Weekly, vol. 13, no. 25, Aug. 29, 1921, pp. 591–594, 17 figs. Gives tables of data for rib design and direct stresses in rib trusses. Test data on 45 ft. truss ribs. (Concluded.)

Zeppelin. The 1000 Hp. Passenger-Carrying Aeroplane of the Zeppelin works in Staaken, K. Rohrbach. Eng. Progress, vol. 2, no. 11, Nov. 1921, pp. 259–262, 6 figs. Entirely constructed of duralumin. Attained a velocity of 211 km. per hour at trial flights. Equipped with four 260-hp. Maybach engines.

[See also FLYING BOATS; SEAPLANES.]

AIRSHIPS

Commercial Transportation. Commercial Transportation By Dirigibles (Le trafic commercial par ballons dirigeables), L. Hirschauer. La Technique Moderne, vol. 13, no. 6, June 1921, pp. 241–249, 4 figs. Discusses developments, speed and regularity of trips already made, and freight capacity; calculates cost for various lines from Paris.

Mooring. The Mooring of Airships, G. H. Scott. Flight, vol. 13, no. 48, Dec. 1, 1921, pp. 803–804. Discusses mooring on surface of land or water; mooring in the air on one or more wires, and towing; and mooring at a mast. Extract of paper read before Cambridge Univ. Aeronautical Soc.

Non-Rigid, Stresses in. Bending Moments, Envelope, and Cable Stresses in Non-Rigid Airships, C. P. Burgess. Nat. Advisory Committee for Aeronautics, report no. 115, 1921, 14 pp., 4 figs. Describes theory of calculations and methods in use in U. S. Navy Bur. of Aeronautics. Principal stresses are said to be due to gas pressure and unequal distribution of weight and buoyancy, and concentrated loads from car suspension cables. Deals also with variations of tensions in car suspension cables of any type of airship, with special reference to rigid type, due to propeller thrust or inclination of airship longitudinally.

Passenger. Airships for Passenger Transportation, Ralph Upson. Aviation, vol. 11, no. 21, Nov. 21, 1921, pp. 598–600, 5 figs. Discusses advantages of aerial transportation and size and type of ships and terminals. Paper presented to Int. Aero Congress.

The Employment of Airships for the Transport of Passengers, Umberto Nobile. Aerial Age Weekly, vols. 13 and 14, nos. 26, 1 and 2, Sept. 5, 12 and 19, 1921, pp. 618–620, 12–14 and 33–37, 9 figs. Indications on the maximum limits of their useful load, distance covered, altitude and speed. From Giornale del Genio Civile, Anno LIX, 1921.

Spain-Argentine Service. Spain to Argentine Airship Service. Aviation, vol. 11, no. 23, Dec. 5, 1921, pp. 656–658, 3 figs. Three Zeppelins are to be used costing about $7,000,000 with terminal facilities costing $8,000,000.

ALCOHOL

Industrial. Manufacture of Industrial Alcohol from the Carob Bean (La fabbricazione industriale dell' alcohol dalle carrube), Giuseppe Mezzadroli. Giornale di Chimica Industriale ed Applicata, vol. 3, no. 9, Sept. 1921, pp. 399–403. Describes such a plant at Catania; extraction of the sugar, fermentation, distillation and rectification; makes recommendations.

ALLOY STEELS

Cracking During Dip Brazing. Report on Cause of Cracking of Alloy Steels During Dip Brazing. Air Service Information Circular, vol. 3, no. 295, Oct. 20, 1921, 3 pp., 2 figs. Results of investigation show that two influences contribute to cracking, namely, a sudden rise in temperature after immersion in brass, and sharp changes in cross-sectional area in specimen. Slow preheating to brazing temperature is said to obviate this difficulty.

Impact Tests. Effect of Repeated Impact on Steels (Influence des chocs repétés à la compression sur les aciers), Fernand Éloy. Révue de l'Industrie Minérale, no. 19, Oct. 1, 1921, pp. 603–606. Discusses tests with special and carbon steels, showing superiority of former.

Tool Steel. Tool-Steel Specifications—A Hard Nut to Crack, Charles M. Brown. Raw Material, vol. 4, no. 10, Oct. 1921, pp. 349–352. Advocates formulation of definite standards as an advantage from user's point of view.

ALLOYS

Carbon-Chromium-Silicon. A New Carbon-Chromium-Silicon Resistance Material. Raw Material, vol. 4, no. 10, Oct. 1921, pp. 359–361, 4 figs. Discusses physical properties of "Silchrome" and gives results of tests made at Columbia University for electric resistance, etc.

Chemical Properties. The Chemical Properties of Alloys (Die chemischen Eigenschaften der Legierungen), G. Tammann. Zeit. fur Metallkunde, vol. 13, no. 12, Sept. 1921, pp. 406–419 and (discussion) pp. 419–424, 27 figs. Deals with limits of influence of chemical media on mixed crystals and the electro-thermal behavior of alloys.

Distribution of Metals in. A Method for Determination of the Percentage Distribution of Metals in Alloys Whose Qualitative Composition is Known (Ueber eine Methode zur Bestimmung der prozentualen Verteilung von Metallen in Legierungen, deren qualitative Zusammensetzung bekannt ist), Karl Schmidt. Chemiker-Zeitung, vol. 45, no. 103, Aug. 27, 1921, pp. 825–826. Method is developed with which it is possible to determine quantitatively the composition of an alloy without destroying it and with the same accuracy as is obtainable by weight analysis.

[See also ALUMINUM ALLOYS; BEARING METALS; MAGNESIUM ALLOYS.]

ALUMINUM

Chill Casting. Chill Casting of Aluminum (Le Moulage en Coquille de l'Aluminium). La Fonderie Moderne, no. 9, Sept. 1921, pp. 254–256, 2 figs. Describes the various operations and alloys to be used.

Industrial Applications. New Industrial Application of Aluminum, Magnesium, Calcium and Sodium (Conférences et exposition publiques des nouvelles applications industrielles de l'aluminium, du magnesium, du calcium et du sodium). Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 7, July-August-September 1921, pp. 683–956, 186 figs. partly on supp. plates. Papers read at recent Aluminum Exposition, discussing manufacture, properties, alloys, castings, use in electric and food industries, welding, enameling, etc. See also Revue de Métallurgie, vol. 18, no. 9, Sept. 1921, pp. 541–607, 43 figs.

ALUMINUM ALLOYS

Bronzes. On the Heat-Treatment of Aluminum Bronze, A. A. Blue. Chem. & Met. Eng., vol. 25, no. 23, Dec. 7, 1921, pp. 1043–1048, 25 figs. Concludes from experiments that heat treatment produces marked and consistent changes in Brinell and scleroscope hardness and has little or no effect on tensile strength and yield point.

Heat Treatment. Heat Treatment of Certain Complex Aluminum Alloys (Sur le traitement thermique de certains alliages complexes d'aluminium), Léon Guillet. Comptes Rendus des Séances de l'Académie des Sciences, vol. 173, no. 21, Nov. 21, 1921, pp. 979–982. Examines part taken by constituents of duralumin (Cu, Mg, Mn, Si, Fe) in the high resistance of the alloy; describes experiments with Al-Cu, Al-Si, Al-Si-Mg, Al-Cu-Si-Mg alloys.

Researches. Researches on Aluminium Alloys, Walter Rosenhain, Sydney L. Archbutt and D. Hanson. Engineering, vol. 112, nos. 2913 and 2914, Oct. 28 and Nov. 4, 1921, pp. 613–615 and 644–645, also Engineer, vol. 132, nos. 3435 and 3436, Oct. 28 and Nov. 4, 1921, pp. 461–463 and 489–490. Brief account of principal contents of report to Alloys Research Committee. Deals with cast and wrought alloys; permanence and constitution of alloys.

APPRENTICES, TRAINING OF

Shipyards. American Shipyard Apprenticeships, Evening Schools and Scholarships, Charles F. Bailey. Advance Copy, Soc. of Naval Architects & Mar. Engrs., meeting Nov. 17–18, 1921, no. 8, 10 pp., 1 fig. Reviews present situation, including requirements for apprenticeship, pay, bonus, evening schools, scholarships, etc., and makes suggestions for improvement.

AUTOMOBILE ENGINES

Anti-Freezing Solutions. Anti-Freezing Solutions, O. B. Zimmerman. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 307–310 and (discussion) 310–312. Progress report of Committee of S.A.E., discussing cooling media and their ideal requirements.

Camshafts. Manufacture of Accurate Camshafts. Machinery (Lond.), vol. 19, no. 477, Nov. 17, 1921, pp. 189–194, 9 figs. Description of important operations, and complete tabulated data on manufacturing procedure in making camshafts for a high-grade motor-car.

Carburetors. See CARBURETORS.

Cylinders. Machining the "Bean" Motor Cylinder I. William Chubb. Am. Mach., vol. 55, no. 21 Nov. 24, 1921, pp. 827–830, 10 figs. Methods used in well-equipped English motor plant. Cylinders produced on American machine tools. Power-washing machine.

The Molding of Automobile Cylinder Blocks (Formerei von Auto-Zylinderblöcken), Carl Irresberger. Stahl u. Eisen, vol. 41, nos. 35, and 43, Sept. 1 and Oct. 27, 1921, pp. 1217–1222 and 1529–1533, 48 figs. Notes on upright molding of a one-piece six-cylinder block.

Peugeot Co., France. Internal Combustion Engines of the Peugot Automobile Company (Le moteur à injection de la Société des Automobiles Peugeot) Henri Petit. La Technique Automobile et Aerienne vol. 12, no. 113, 1921, pp. 42–49, 4 figs. Discusses construction and operation of the various parts including combustible mixture, atomizer, injector pumps, regulators, etc.

The Heavy Oil Engine of the Peugeot Automobile Co. (Le Moteur a huile lourde de la Société des Automobiles Peugeot), Henri Petit. La Vie Automobile, vol. 17, no. 741, Nov. 10, 1921, pp. 415–421, 7 figs. Describes the Peugeot motor (Tartrais patent) principles of which are (1) combustion in a hot chamber, (2) high compression, (3) constant volume combustion, (4) fuel injection in cylinder head. Atomizer, feed pump, efficiency, etc.

AUTOMOBILE FUELS

Air-Fuel Mixtures. Condensation Temperatures of Gasoline and Kerosene-Air Mixtures, Robert E. Wilson and Daniel P. Barnard. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 313–319, 11 figs. Describes simple and reliable method for determining temperatures of initial condensation of fuels from air-fuel mixtures, and an approximate method of determining temperatures of partial condensation in such mixtures. From paper read before Am. Chem. Soc.

Benzol. See BENZOL.

Mixed. Diagram for Mixed Automobile Fuels (Kechentafel fur Mischkraftstoffe), Wa. Ostwald. Chemiker-Zeitung, vol. 45, no. 112, Sept. 17, 1921, p. 897, 1 fig. Presents triangle chart for determination of specific weight and heating value for mixtures of benzol, tetraline and alcohol when percentage weight of composition is known.

Oil-Shale. Motor Car Fuel Prospects in the Oil Shales. Automotive Manufacturer, vol. 63, no. 7, Oct. 1921, pp. 7–10. Discusses quality and composition, distillation analysis, and production with steam.

Standard German. Germany's New Standardized Motor Fuel, Benno R. Dierfeld. Automotive Industries, vol. 45, no. 20, Nov. 17, 1921, pp. 974–975, 2 figs. Mixture of benzol and alcohol with tetralene has produced excellent results in road tests and races.

AUTOMOBILES

Beardmore 11-Hp. The 11 hp. Beardmore. Autocar, vol. 47, no. 1357, Oct. 22, 1921, pp. 717–718, 3 figs. Describes 1922 model embodying minor modifications.

Belsize-Bradshaw 9-Hp. The 9 hp. Belsize-Bradshaw. Autocar, vol. 47, no. 1358, Oct. 29, 1921, pp. 803–804, 4 figs. Specifications and description, including oil cooling for engine, automatic oil lubrication, etc.

Brakes, Four-Wheel. The History of Four-Wheel Brakes. Autocar, vol. 47, no. 1361, Nov. 19, 1921, pp. 1057–1064, 21 figs. A series of articles on brakes, including, operating front wheel brakes, Servo brakes, and four-wheel brake tests.

Design. Car Design and Production. Autocar, vol. 47, no. 1362, Nov. 26, 1921, pp. 1123–1126, 7 figs. Shows how design, workshop processes and material costs influence selling price of a motor vehicle.

Frame Stresses. Automobile Frame Stresses, Ethelbert Favary. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 301–303 and (discussion) 303–306, 3 figs. Gives frame-stress calculations intended to enable the designer to proportion frames and parts with the view of eliminating some of the factors that are productive of excessive weight which causes fuel wastage. Laboratory tests of tensile strength, elastic limit, yield point, etc., of materials.

Francon Light. The Françon Light Car (La Voiturette Francon), A. Contet. La Vie Automobile, vol. 17, no. 739, Oct. 10, 1921, pp. 369–372, 7 figs. 10 hp; two separate cylinders; consumes 296 gr. gasoline per hp.-hr. Detailed description of construction and equipment.

German 1921 Show. The German Automobile Exhibition 1921, A. Heller. Eng. Progress, vol. 2, no. 11, Nov. 1921, pp. 241–246, 9 figs. Discusses motors, carburetors, radiators, electric equipment, head lights, speed change gear, back-axle drive, road wheels and springs.

The German 1921 Automobile Show (Die Deutsche Automobil-Ausstellung 1921), A. Heller. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 45, Nov. 5, 1921, pp. 1155–1159, 7 figs. Most important

innovations are said to be use of suspended inlet valves and steel cylinders for engines; the dimensioning of cylinders in excess of requirement of their driving gear, which makes it possible to construct car without the usual control-gear mechanism; progress in field of electric starting and lighting installations new Rumpler rear-axle drive; and new aluminum-silicium alloy known as silumin, from which complete rear-axle housings are cast.

Italian S.P.A. The 30-40 hp. Six-Cylinder S.P.A. Autocar, vol. 47, no. 1358, Oct. 29, 1921, p. 794, 2 figs. Specifications and description, including anti-rolling device.

Machining Differential Gear Case. Methods and Tools Used in Machining the Peerless Differential Carrier and Gear Case, Fred H. Colvin. Am. Mach., vol. 55, no. 23, Dec. 8, 1921, pp. 912–914, 11 figs. Turret lathe tooling for special jobs; drilling fixture for rapid handling of work; gages for surfaces which are not easy of access.

Mechanical Features. Progress in Design. Autocar, vol. 47, no. 1360, Nov. 12, 1921, pp. 945–953, 21 figs. Notes on engine design, gas passages, valves, lubrication, carburation, transmission, brakes, steering, suspension, and wheels.

Repair Service. Automotive Service Methods and Equipment, Howard Campbell. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 870–873, 7 figs. Details of service plant of Hellman Motor Corp., Long Island City, N. Y.

Rumpler Streamline. The New Rumpler Streamline Automobile ("Tropfenwagen"), Curt Eppinger. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 19, Oct. 15, 1921, pp. 287–289, 11 figs. Based on experiences in airplane construction. Entire drive is located in rear and the streamline form is adopted for body. Advantages and possibilities of new type are set forth.

Standard Motor Co. An 8 hp. Four-Cylinder Standard. Autocar, vol. 47, no. 1358, Oct. 29, 1921, pp. 791–793, 8 figs. Specifications and description of Standard Motor Co.'s 8-hp. and 11-hp. cars.

AVIATION

Commercial. Commercial Aviation in France (L'Aviation Commerciale Française), L. Hirschauer. La Technique Moderne, vol. 13, no. 4, April 1921, pp. 145–153, 12 figs. Gives tabulation of lines in existence; shows development of aerial transport companies, their flying machines and government action; reviews activity in other countries.

Technique and Economics in Commercial Aviation (Technik und Oekonomik im Luftverkehr mit Flugzeugen), E. Offermann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, nos. 19 and 20, Oct. 15 and 31, 1921, pp. 289–298 and 301–302. Oct. 15. Technical requirements of traffic airplanes with special regard to the Junkers airplanes. Oct. 31: Organization problems of air traffic. Prospects of air traffic in Argentine.

Developments and Progress. Aviation, Present and Future (L'Aviation d'hier and de demain), Louis Breguet. L'Aerophile, vol. 29, no. 17–18, Sept. 1–15, 1921, pp. 265–272, 1 fig. Discusses from a technical standpoint what has been accomplished so far and what the possibilities are for aerial transportation.

B

BALANCING

Reciprocating Masses. The Exponential Method in the Analysis of the Balance of Reciprocating Masses, P. Cormack. Engineering, vol. 112, no. 2919, Dec. 9, 1921, pp. 778–780, 1 fig. Calculation of inertia forces for radial and rotating cylinder engines.

Rotating Parts. Balancing Rotating Parts (Sur l'equilibrage des pieces en rotation), P. Lemaire. Le Technique Moderne, vol. 13, no. 6, June 1921, pp. 249–257, 27 figs. Discusses static and dynamic balancing of machinery.

BALLOONS

Pilot. Resistance of Air to Spheres and the Rising Speed of Pilot Balloons (La résistance de l'air au mouvement des sphères et la vitesse ascensionnelle des ballons pilotes), C.-E. Brazier. Compt. Rendus des Séances de l'Académie des Sciences, vol. 173, no. 16, Oct. 17, 1921, pp. 644–646. Discusses determination of K, the coefficient of resistance, and gives table of calculated and experimental values for it.

BEAMS

Irregularly Distributed Loads. Beams with Loads Irregularly Distributed, T. Thompson. Engineering, vol. 112, nos. 2915 and 2916, Nov. 11 and 18, 1921, pp. 656–658 and 686–689, 7 figs. Describes method for speedy and accurate calculation of bending moments and deflections of beam with irregularly distributed loading.

BEARING METALS

Babbitt. Characteristics of Bearing Metals, Edward T. Keenan. Power, vol. 54, no. 25, Dec. 20, 1921, pp. 977–978. Composition of various babbitt metals for various kinds of bearings. List of babbitts and their compounds.

Industrial Value. Bearing Metals and Their Industrial Value, J. Czochralski. Brass World, vol. 17, nos. 9 and 10, Sept. and Oct. 1921, pp. 245–248 and 281–286, 33 figs. Sept.: Discusses alloys in which tin is replaced by lead, and experiments carried out for the purpose. Oct.: Methods of testing and comparative efficiency of bearing metals. (Abstract.) Zeit. f. Metallkunde.

BEARINGS

Hand vs. Machine-Finished. Hand Versus Machine Finished Bearings, E. A. Dixie. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 888–890. Comparison of machine and hand-finished surfaces. Some examples of better and quicker work.

BEARINGS, BALL

Friction and Safe Load. Friction and Carrying Capacity of Ball and Roller Bearings, H. L. Whittemore and S. N. Petrenko. U. S. Bur. Standards Technologic Papers, no. 201, Oct. 6, 1921, 34 pp 30 figs. Account of experiments undertaken to determine maximum safe load and static friction under load of ball and flexible roller bearings. Results agree roughly with Hertz's theory, differences being ascribable to inhomogeneity of material.

Grinders. Use of Ball Bearings as Adapted to Grinders, Donald A. Hampson. Can. Machy., vol. 26, no. 17, Oct. 27, 1921, pp. 30–32 and 36, 9 figs. Discusses advantages as to lower cost of production, increased output, higher efficiency, saving of power, etc.

BEARINGS, ROLLER

Calculation. Practical Calculations of Roller Bearings (Calcul pratique des roulements a rouleaux), P. Massot. La Technique Moderne, vol. 13, no. 5, May 1921, pp. 193–197, 3 figs. Discusses cylindrical and conical roller bearings and works out formulas. Comparison with ball bearings.

Types. Usual Forms of Roller Bearings (Les formes usuelles de roulements a rouleaux), La Technique Moderne, vol. 13, no. 6, June 1921, pp. 258–263, 22 figs. Describes products of various American, British, French and Swedish firms.

BENZOL

Production in Gas Works. The Production of Benzol in Medium-Size and Small Gas Works (Die Benzolgewinnung in mittleren und kleinen Gaswerken), H. Menzel. Gas- u. Wasserfach, vol. 64, no. 19, May 7, 1921, pp. 294–296, 2 figs. Describes improved type of benzol plant constructed by Berlin-Anhalt Machine Constr. Corp. by means of which, it is claimed, a quality of benzol well adapted for engine drive can be recovered from gas produced in gas works.

BLAST-FURNACE GAS

Burning under Boilers. Burning Blast-Furnace Gas Under Boilers, Gordon Fox and F. H. Willcox. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 930–931. Discusses gas burner, ignition, combustion chamber, baffling, and draft losses through boiler passes.

BLIND

Employment of. The Employment of the Blind in Workshops. Engineering, vol. 112, no. 2917, Nov. 25, 1921, pp. 715–717, 7 figs. Deals with experience gained in Germany in employment of blind on machine work, and machining operations performed by blind at the Siemens-Schuckert Works.

BLUEPRINTING

High-Speed Machine. A High-Speed Blue Printing Machine. Engineer, vol. 132, no. 3438, Nov. 18, 1921, p. 345, 5 figs. Describes new photo-printing machine brought out by B. J. Hall & Co., Ltd., London.

BOAT LIFTS

120-ft. Lift. Elevators for Raising Boats to Considerable Heights (Elevators di navi per grandi altezze de sollevamento). L'Industria, vol. 35, no. 17, Sept. 15, 1921, pp. 391–394, 5 figs. Describes installation designed by four German companies for raising boats 36 meters, which works successfully.

BOILER FEEDWATER

Treatment. Boiler Feed Water Treatment and Treatment Control, E. C. Bashore. Power Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1050–1052. Causes of scale, corrosion, foaming, embrittlement, and methods of treatment. (Abstract). Paper read at Nat. Exposition of Chem. Industries.

The Interior Treatment of Boiler Waters. C. R. Knowles. Ry. Age, vol. 71, no. 20, Nov. 12, 1921, pp. 935–936. Discusses introduction of substances into boiler to prevent scale, corrosion, foaming or other ill effects of bad water.

The Treatment of Boiler Feed Water, Robert June. Power House, vol. 14, no. 21, Nov. 5, 1921, pp. 21–23, 3 figs. Discusses artificial zeolite systems and evaporating methods.

BOILER OPERATION

Coal Consumption, Control of. The Influence of Weather on Coal Consumption, Malcolm C. W. Tomlinson. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 321–326, 13 figs. Describes method of using outside temperatures to check boiler operation.

BOILER PLANTS

Economical Design. Boiler and Furnace Economy, D. S. Jacobus. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 779–782. Deals with such questions as when it will pay to use economizers in a new plant; most economical rating at which to operate a boiler; limitations imposed on efficiency by inability of furnace brickwork to withstand temperatures available with many classes of fuel; furnace volume and length of flame travel; use of air heaters, etc.

Boiler-House Management, David Brownlie. Iron & Coal Trades Rev., vol. 103, nos. 2803 and 2804, Nov. 18 and 25, 1921, pp. 721–722 and 700–702. Nov. 18: Discusses efficient design and equipment of boiler plant and scientific control of the working of the plant. Types of boilers and relative advantages and disadvantages. Nov. 25: Discusses mechanical stoking, economizers and feedwater heaters, superheaters, forced or induced draft, and auxiliary machinery. (Abstract). Paper read before South Wales Inst. Engrs.

Steam Accumulators. Steam Accumulators, System Ruths (L'Accumulateur de vapeur Ruths), E.-G. Constam-Gull. Le Génie Civil, vol. 79, no. 22, Nov. 26, 1921, pp. 453–457, 13 figs. A Swedish patent apparatus designed to equalize boiler pressure. Describes a number of installations in metallurgical and electric power plants.

BOILERS

Corrosion. Corrosion Caused by Carbonic Acid (Rostbildung durch Kohlensäure), G. Bruhns. Chemiker-Zeitung, vol. 45, no. 111, Sept. 15, 1921, pp. 885–887. Gives results of investigation of corrosive effect of free carbonic acid in steam and condensation water, and means for its prevention.

Preheating with Flue Gas. Utilizing Flue Gases to Preheat Air to Furnace—Consideration o Some of the Problems Involved, E. R. Welles and C. T. Mitchell. Power, vol. 54, no. 22, Nov. 29, 1921, pp. 844–846, 1 fig. Points out that rough calculations (the best that can be made with available data indicate reasonable possibility of economic application of preheating.

Water Works. Selecting Steam Boilers for Water Works, F. W. Dean. Fire & Water Eng., vol. 70, nos. 22 and 23, Nov. 30 and Dec. 7, 1921, pp. 1007–1008, 1014 and 1027–1029 and 1053–1054 and 1058. Importance of choosing most economical type. Various kinds of boilers with their characteristics considered. Proper setting and fuel to be used. Boiler safety. (Abstract). Paper read before N. E. Water Works Assn.

BOILERS, WATER-TUBE

Vertical. Feedwater-Heater Vertical Water-Tube Boilers with Combined Trough-Grate and Step-Grate Furnace for Burning Low-Grade Lignite (Vorwärmer-Steilrohrkessel mit kombinierter Muldenrost-Treppenrostfeuerung zur Verbrennung minderwertiger Braunkohle). Wärme- u. Kälte-Technik, vol. 23, no. 14, July 15, 1921, pp. 159–160, 1 fig. Points out advantages of new boiler system which consists of three upper drums connected with the two bottom drums through tubes. Built by Karlsruhe Machine Constr. Corp.

BRAKES

Combination Air and Vacuum. Brakes on the Paulista Railroad (Frenos para el Ferrocarril Paulista), F. H. Parke. Ingenieria Internacional, vol. 6, no. 6, Dec. 1921, pp. 348–351, 3 figs. A combination of air and vacuum brake for electric locomotives drawing trains provided with air brakes, constructed by Westinghouse Air Brake Co.

Pneumatic. Continuous Brake for Freight Trains (Le freinage continu des trains de marchandises), G. Tongas. La Technique Moderne, vol. 13, no. 10, Oct. 1921, pp. 417–425, 6 figs. Describes the Lipkowski brake, a single chamber pneumatic brake, used on some French locomotives for seven years with success.

Westinghouse Double-Capacity. Exceptional Train Loading in the United States and the Westinghouse Double Capacity Brake. Ry. Gaz., vol. 35, no. 21, Nov. 18, 1921, pp. 769–771, 5 figs. Tests with 75,100 and 110-car coal trains, respectively 12,000, 16,000 and 17,250 American tons, on Virginian railway, fitted with Westinghouse empty and load brake.

BRASS

Compressibility. Compressibility of Brasses at Temperatures up to 800 Deg. C. Engineering, vol. 112, no. 2918, Dec. 2, 1921, p. 770, 3 figs. Results of series of experiments on compressibility of copper and various brasses at temperatures ranging from 20 to 800 deg. cent. carried out at Hirsch Brass Works, Inc., Eberwalde, Germany. Translated from Zeit. für Metallkunde, vol. 12, pp. 340–358 and vol. 13, pp. 305–315.

Heat Treatment. Heat-Treatment of Brass and Brasses Containing Tin, Léon Guillet. Chem. & Met. Eng., vol. 25, no. 22, Nov. 30, 1921, pp. 1009–1014, 16 figs. Brasses containing a little beta respond to heat treatment; tin brasses, developing special constituent analogous to delta in bronzes, may have their physical properties changed very notably by proper annealing and quenching. From Revue de Métallurgie, July 1921.

Hot-Working. Hot Working of Brass (Le travail du laiton a chaud), A. Devilliers. La Technique Moderne, vol. 13, no. 5, May 1921, pp. 206–209, 8 figs. Discusses hot rolling, critical content of lead, effect of aluminum and pros and cons of hot and cold working.

BRASS FOUNDING

Electric-Furnace Melting. Brass Melting in Electric Furnaces (Messingschmelzen im elektrischen Ofen), Herbert Hein. Siemens-Zeit., vol. 1, no. 10, Oct. 1921, pp. 380–385, 5 figs. Describes induction furnace developed during war. Furnaces of this type for three-phase and two-phase current and charges of 500 to 1000 kg. have been in operation for several years, consuming 100 and 150 kw. at power factor of 0.4 to 0.6 at 50 cycles. Higher hygienic qualities are claimed for induction furnace than for one of arc type due to smaller amount of injurious zinc fumes.

BUSHINGS

Drill. Drill Bushings (Bohrbuchsen), Fritz Herkner. Betrieb, vol. 4, no. 1, Oct. 8, 1921, pp. 8–12, 32 figs.

For giving to drills, reamers, countersinks, etc. the necessary accuracy in guidance, direction and position. Notes on their manufacture, dimensions, adjustment, and security against being pulled out.

C

CALORIMETERS

Gas. A New Gas Calorimeter (Ein neues Gaskalorimeter), E. Langthaler. Gas- u. Wasserfach, vol. 64, no. 6, Feb. 5, 1921, pp. 83-86, 2 figs. Describes Union calorimeter designed by O. Dommer, which, as shown by test results, has a high degree of accuracy. It is easily transportable and adaptable for many uses.

Recording. Report on Recording Calorimeters. Gas World, vol. 75, no. 1943, Oct. 15, 1921, pp. 314-319 and (discussion) 319-321, 5 figs. Fifth report of Research Sub-Committee of Gas Investigation Committee giving results of tests made.

CAR LIGHTING

Generators. The Economy of Electric Car Lighting (Die Wirtschaftlichkeit elektrischer Zugbeleuchtung), H. Hoepner. Verkehrstechnik, vol. 38, no. 25, Sept. 5, 1921, pp. 383-395. Demonstrates advantages of generator lighting with auxiliary batteries over pure storage-battery lighting.

CARBURETORS

Aircraft. Instructions to Designers of Aircraft Carburetors. Air Service Information Circular, vol. 3, no. 291, Oct. 20, 1921, 4 pp., 2 figs. Deals with general requirements of carburetor design, gasoline inlet connection, gasoline strainer, float chamber, metering jets, air intake pipe, venturis, throttles, mixture control, performance, tests inspection, etc.

Griffon. The Griffon Carburetor (La carburateur Griffon), Henri Petit. La Vie Automobile, vol. 17, no. 739, Oct. 10, 1921, pp. 378-381, 4 figs. Discusses the various parts and their operation.

Kerosene Carburetion. Actual State of Kerosene Carburetion (Etat actuel de la carburation au petrole lampant), Sigma. La Metallurgie, vol. 53, no. 45, Nov. 10, 1921, pp. 2101-2102. Discusses mixing, ignition, combustion, flame control, etc. (Concluded)

Metering Characteristics. Report on the Control of Carburetor Metering Characteristics by the Supplementary Admission of Air. Air Service Information Circular, vol. 3, no. 292, Oct. 20, 1921 14 pp., 9 figs. Results of test to determine characteristics of mixture-control device operating on principle of supplementary admission of air, particularly as applied to high-compression, over-dimensioned aviation engine, under laboratory and flight conditions.

Testing Zenith. Testing a Zenith Carburetor (Essai d'un carburateur Zénith a triple diffuseur sur voiture 16 hp. Panhard S.S.), Henri Petit. La Vie Automobile, vol. 17, no. 739, Oct. 10, 1921, pp. 374-375, 2 figs. Details of three tests on a 16-hp. Panhard.

CARS

Electric. Illinois Central Steel Suburban Coaches. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921 pp. 755-759, 11 figs. Designed for future electrification; doors electrically controlled; total weight 92,100 lb.

CARS, COAL

Steel Hopper. All-Steel Coal Hopper Wagons for Bengal-Nagpur Railway. Ry. Engr., vol. 42, no. 502, Nov. 1921, pp. 405-409, 5 figs. High-capacity hopper wagons constructed by Midland Railway Carriage & Wagon Co., Ltd., Birmingham, for Bengal-Nagpur Railway, to the design of J. W. Barry.

CARS, FREIGHT

Box. The Use of Ordinary Box Cars for Shipping Fruit, Vane G. Gibson and Herbert Graff. Ry. Rev., vol. 69, no. 20, Nov. 12, 1921, pp. 643-646, 7 figs. Tests undertaken by Department of Agriculture show most practical means for ventilating box cars. (Abstract).

Container. Avoidable Waste in Car Operation—The Container Car, Walter C. Sanders. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 799-802, 9 figs. Describes "container" cars recently placed in service on N. Y. Central lines and others having improvements on original type which are now under construction. Advantages of described car are enumerated.

Wood in Construction of. The Use of Wood in Freight Car Construction, H. S. Sackett. Ry. Age, vol. 71, no. 22, Nov. 26, 1921, pp. 1037-1042, 6 figs. Relative advantages of double- and single-sheathed box car; composite gondola car; advantages of composite design; etc. Gives table of lumber grades and dimensions.

CARS, PASSENGER

All-Steel. Illinois Central Suburban Operation and Equipment. Ry. Rev., vol. 69, no. 21, Nov. 19, 1921, pp. 669-677, 14 figs. Describes new all-steel cars just put in service as first step toward electrification.

New All-Steel Suburban Coaches for the South African Railways. Ry. Gaz., vol. 35, no. 20, Nov. 11, 1921, pp. 722-725, 6 figs. Describes all-steel composite bogie coaches built by Leeds Forge Co., Ltd., constructed on central gangway principle.

Design. On the Question of Passenger Carriages, W. J. Tollerton. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1399-1440, 52 figs. Gives list of questions and answers regarding general types and arrangements of passenger carriages used in U. S., Canada and Mexico, details of construction of principal parts of carriages, lighting, heating, ventilating, etc.

CARS, TANK

Milk. Handling Milk in Specially Constructed Tank Cars. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 763-764, 3 figs. Large glass-lined steel tanks save expense in handling and haulage; refrigeration in transit eliminated.

CAST IRON

Self-Corrosion. Self-Corrosion of Cast Iron and Other Metals in Alkaline Soils, W. Nelson Smith and J. W. Shipley. Elec. Ry. Jl., vol. 58, no. 21, Nov. 19, 1921, pp. 911-912. Results of investigation to show that city water main external corrosion could not be due to electrolysis from stray currents. (Abstract.) Paper read before Eng. Inst. of Can.

CENTRAL STATIONS

Auxiliary Drives. Relation of Auxiliary Drives to Heat Balance, J. R. McDermet. Power, vol. 54, no. 23, Dec. 6, 1921, pp. 888-890, 1 fig. Deals with direct steam drive, motor drive, house turbines, combination drives, and feedwater heating by bleeder condensers.

Hartford, Conn. South Meadow Station. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1177-1184 and 1210-1217, 23 figs. Describes new plant of Hartford Elec. Light Co. with ultimate capacity of 130,000 kw. at 11,000 volts. Centrifugal auxiliary pumps, inbuilt economizers, washed air for cooling generators, centralized station control. See also Elec. World, vol. 78, no. 24, Dec. 10, 1921, pp. 1163-1166, 6 figs.

Manchester, N. H. Central Station Service for Manchester, N. H. Power Plant Eng., vol. 25, no. 22, Nov. 15, 1921, pp. 1079-1087, 13 figs. Hydro-electric and steam standby stations of Manchester Traction, Light & Power Co.

Oakland, Cal. Oakland Station of the Pacific Gas & Electric Co., Charles W. Geiger. Power Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1033-1039, 10 figs. Describes 12,500-kw. addition to Station C, turbo-generator, circulating pump, fuel oil, water supply, etc.

Superpower. A Superpower System for the Region Between Boston and Washington, W. S. Murray. U. S. Geol. Surv. professional paper 123, 1921, 261 pp., 61 figs. and 11 supp. plates. Market for superpower energy will be furnished by electric utilities, industries, and railroads. Estimated requirement for energy supplied through electric utilities for municipal, private, industrial, and railroad purposes in 1930 is 31,000,000,000 kw-hr., which could be supplied by coördinated power system such as is described. Study of 96,000 manufacturing establishments operating within superpower zone shows that by 1930, they can save $190,000,000 annually above fixed annual charges against capital investment of $185,000,000. See also Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1185-1187, 1 fig.

CHARTS

Nomograms. Graphic Charts (Graphische Tafeln), Wilhelm Vieser. Bauingenieur, vol. 2, no. 21, Nov. 15, 1921, pp. 569-575, 6 figs. Review of nomographic methods, and construction of charts. Bibliography.

Scale Selection. Scale Selection for Z Charts, Arthur R. Burnet. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 365-370, 4 figs. Describes new method of chart making and curve plotting and compares it with older method.

CHIMNEYS

Tall, Design of. Notes on the Design of Tall Chimneys and Their Foundations, J. M. Wade. Roy. Engrs. Jl., vol. 34, no. 5, Nov. 1921, pp. 209-219, 6 figs. Discusses design, height, draft, and calculations, including calculations of gases formed by combustion of one ton of coal, and for height and outlet of a chimney for furnaces consuming two tons of fuel per hour.

CHROME STEEL

Automobile Industry. Chromium Steels and Irons, Leslie Aitchison. Iron & Coal Trades Rev., vol. 103, no. 2802, Nov. 11, 1921, pp. 686-687. Discusses alloy and carbon steels, effect of alloying on critical temperature, mechanical properties, stainless steels, and vanadium additions, especially in connection with the automobile industry.

Mechanical Properties. Chromium Steels and Iron, Leslie Aitchison. Engineering, vol. 112, nos. 2918 and 2919, Dec. 2 and 9, 1921, pp. 771-772 and 805-807, 5 figs. Brief account of general effect which chromium exerts upon steels, followed by description of mechanical properties of chrome steels. Paper read before Instn. Automobile Engrs.

CHROMIUM

Alloys of. Chromium Alloys (Les alliages industriels de chrome), J. Herbert. La Technique Moderne, vol. 13, no. 5, May 1921, pp. 197-205. Discusses metallic chrome, ferro-chrome, silico-chrome, chrome and chrome-nickel steels, chrome salts, etc.

COAL HANDLING

Plants. Coal and Ash-Handling Plant of the Royal Naval Cordite Factory, Near Poole, George F. Zimmer. Engineering, vol. 112, no. 2916, Nov. 18, 1921, pp. 706-707, 7 figs. Railway sidings on which coal arrives and from which ashes leave, run alongside and parallel with boiler-house; full trucks arrive on inner track and pass over a large track hopper into which coal is dumped by truck tippler, by completely overturning trucks.

Reinforced-Concrete Coal-Handling Plant with Storage Bunker (Kohlenförderanlage in Eisenbeton für den Betrieb der Firma F. A. Schmidt in Guben), A. Burghardt. Beton u. Eisen, vol. 20, no. 16, Oct. 5, 1921, pp. 177-178, 7 figs. Installation built in 1919 consists of a 7.2-m. long, 3.6-m.-wide bunker for storage of 80 cu. m. of lignite; and a smaller bunker, 2.64 m. long and 2.5 m. wide for 20 cu. m.

COLUMNS

Buckling under Axial Load. Buckling of Elastic Structures, H. M. Westergaard. Proc. Am. Soc. Civ. Engrs., vol. 47, no. 9, Nov. 1921, pp. 455-533, 14 figs. Investigation deals with structural actions in which stresses are not proportional to loads, although proportional limit of material has not been exceeded and deflections remain small. Describes astatic and in particular, heterostatic action. Deals also with columns carrying axial and transverse loads at same time. Formulas are given for buckling of slabs and systems of crossing-beams. Classified bibliography.

COMBUSTION

Controlling Rate. Controlling the Rate of Combustion. Sanitary and Heating Eng., vol. 96, no. 11, Nov. 18, 1921, pp. 313-314, 2 figs. Discusses hydraulically operated damper regulators in low pressure heating plants.

COMPRESSED AIR

Intercooling. Value of Intercooling Compressed Air, C. K. Bennett. Power Plant Eng., vol. 25, no. 23, Dec. 1, 1921, pp. 1142-1144, 5 figs. Methods and means of cooling air during and after compression.

Pneumatic Mail Tubes. Pneumatic Street Tubes in London, A. B. Eason. Compressed Air Mag., vol. 26, no. 11, Nov. 1921, pp. 10279-10282, 8 figs. Used for conveying parcels, letters, newspapers and other matter which must be delivered expeditiously. Describes machinery for supplying compressed air, and terminal apparatus.

CONDENSERS, STEAM

Cooling-Water Treatment. Chemical Treatment of Water for Cooling Condensers (Du traitement chimique des eaux servant à la réfrigération des condenseurs), G. Paris. Chaleur et Industrie, vol. 2, no. 18, Oct. 1921, pp. 634-642, 12 figs. Describes Balke process which changes bicarbonate of lime and magnesium into chlorides by addition of hydrochloric acid, and the Hulsmeyer process depending on thermic action and addition of sodium carbonate.

CONVEYORS

Mold. Conveyor System Cuts Moulding Costs, Herbert H. Leonard. Can. Manufacturer, vol. 41, no. 11, Nov. 1921, pp. 31-35, 11 figs. Molding car wheels on jolt machines is made possible by adoption of conveyor systems for transferring molds, flasks and sand, supplemented by I-beam trolleys and gravity conveyors.

New System. Tramrail Reduces Labor Force to Half. Iron Age, vol. 108, no. 24, Dec. 15, 1921, pp. 1523-1525, 3 figs. States that marked reduction in production costs has been effected by Globe Machine & Stamping Co., Cleveland, by installation of new conveying system and japanning equipment.

COST ACCOUNTING

Job Cards. Job Cards, Hubert Bentley. Eng. & Indus. Management, vol. 6, no. 19, Nov. 10, 1921, pp. 533-534, 2 figs. Outlines useful method of keeping distinct record of time taken on jobs for costing purposes. Describes specimen job cards.

COST SYSTEMS

Foundry. Advantages of a Foundry Cost System, Robert E. Belt. Iron Age, vol. 108, no. 21, Nov. 24, 1921, pp. 1351-1353. Points out that it forms basis for establishing selling price and indicates degree of efficiency of various departments. Paper read before Nat. Founders' Assn.

CRANES

Dock. New Special Types of Mammoth Dock Cranes (Neue Sonderbauarten von Riesenwerftkranen im Ausland), H. Wintermeyer. Fördertechnik u. Frachtverkehr, vol. 14, no. 23, Nov. 11, 1921, pp. 289-291, 6 figs. Describes examples of English and American stationary and floating-dock mammoth cranes.

Floating. Floating Crane for Coaling Vessels. Engineering, vol. 112, no. 2919, Dec. 9, 1921, p. 784, 5 figs. partly on p. 592. New crane recently installed in Montreal Harbor by George Hall Coal Co. of Can., Ltd. Its features include a gooseneck boom which enables it to deliver coal into deck shoots on either side of steamer without moving its station. Slewing angle of boom is 180 deg., enabling it to coal not only from its own stock, but from coal barges alongside.

Metallurgical Industry. Modern Cranes and Conveyors in the Metallurgical Industry (Les appareils modernes de levage et de manutention dans l'industrie métallurgique), Lucien Dujardin. L'Outillage, vol. 230, no. 42 Oct. 20, 1921, pp. 1087-1103, 50 figs. A number of articles discussing construction and operation of apparatus for charging furnaces of various systems, electromagnets, crane trucks, etc.

Mounted on Trucks. The Truck with the Giant Arm. Commercial Vehicle, vol. 25, no. 8, Nov. 1921, pp. 30-31, 4 figs. Universal crane, mounted on different trucks, speeds up all types of loading and gives greater flexibility in maneuvering into position.

CRANKSHAFTS

Grinding. Crankshaft Grinding. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, pp. 447-450, 11 figs. Notes on special machines and attachments.

CUTTING METALS

Acetylene Jet-Cutting Machines. Economy in Metal Cutting. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 565–566, 2 figs. Describes Godfrey acetylene jet-cutting machine and its economic advantages.

Oxy-Hydrogen Cutting. Effect of Oxy-Hydrogen Cutting on Locomotive Rods, Arthur F. Pitkin. Am. Mach., vol. 55, no. 24, Dec. 15, 1921, pp. 964–965, 11 figs. Unusual examples of rapid cutting together with data as to its effect on steel used in locomotive rods.

D

DIE CASTINGS

Design and Use. Die Castings and Their Use in Industry, C. T. Roder. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1409–1411. Their relation to consumers of sand or malleable castings. Dies and their construction. Designing of castings.

DIESEL ENGINES

Ansaldo-San Giorgio. 300-Hp. Two-Cycle Diesel Engine. Engineering, vol. 112, no. 2917, Nov. 25, 1921, pp. 721–722, 10 figs. on supp. plate. Describes new series of engines built by Ansaldo-San Giorgio of Turin and Spezzia, Italy, intended primarily for industrial purposes. Results of tests with two-stroke, single-acting engine with three vertical cylinders.

Beardmore-Tosi. Trials of the Beardmore-Tosi Diesel Engine. Engineer, vol. 132, no. 3437, Nov. 11, 1921, pp. 508–510, 12 figs. one on p. 512. Results of trial are presented. Beardmore-Tosi engine, salient features of which are described, is said to mark distinct advance in four-cycle engine construction. See also Shipbldg. & Shipg. Rec., vol. 18, no. 19, Nov. 10, 1921, pp. 605–606, 3 figs. on pp. 600–601.

Compressorless. A Compressorless Diesel Engine. Power Plant Eng., vol. 25, no. 23, Dec. 1, 1921, pp. 1146–1147, 2 figs. Fuel injected without air, under pump pressure; gradual combustion at constant pressure; air compressed by lower end of piston; crosshead to take connecting-rod thrust.

Electricity Supply and. The Function of the Heavy Oil Engine in Connexion with the General Supply of Electricity, Geoffrey Porter. Gas & Oil Power, vol. 17, no. 194, Nov. 3, 1921, pp. 22–24, 2 figs. Discusses oil fuels, Diesel engine design, especially the Still engine, and advantages of heavy-oil engines based on comparative figures. From paper read before Diesel Engine Users' Assn.

Fishing Boats. Engines for Fishing Boats (Le moteurs de bateaux de pêche), Edmond Marcotte, La Technique Moderne, vol. 13, no. 7, July 1921, pp. 298–305, 9 figs. Describes various types of semi-Diesel and Diesel engines.

German Submarine. The Augsburg Ten-Cylinder Four-Stroke-Cycle U-Boat Diesel Engine, John L. Bogert. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 932–933, 2 figs. Characteristics of the Augsburg 3000-hp. high-speed engine designed by I. Lauster, used on German submarines.

Sulzer. The New Sulzer Diesel Engine, A. P. Chalkley. Mar. Eng., vol. 26, no. 11, Nov. 1921, pp. 845–846, 2 figs. Describes new Sulzer marine Diesel engine with turbo-scavenging; 1,350 b.hp. at 95 r.p.m.; built by Winterthur works and being installed in a 9,000-ton deadweight motorship.

DISABLED MEN

Training of. On Behalf of the Industrial Disabled, Gerald A. Boate. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 345–352, 2 figs. Includes alphabetical list of occupations in which disabled men have been retrained. Scientific selection of suitable occupations for disabled men.

DRAWINGS

Production and. Drawings and Production. Eng. Production, vol. 3, no. 62, Dec. 8, 1921, pp. 533–536. Discussion of Albert F. Guyler's paper with above title read before Instn. Production Engrs.

Suggestions for Making. Drawings and Production. Albert F. Guyler. Eng. Production, vol. 3, no. 61, Dec. 1, 1921, pp. 509–513, 13 figs. Suggestions for the making of drawings. Paper presented before Instn. Production Engrs.

DRILLING MACHINES

Radial. Centralized Control Radial Drilling Machine Machinery (Lond.), vol. 19, no. 477, Nov. 17, 1921, pp. 197–202, 8 figs. A new tool in which all the means of control are grouped together near working position of operator.

Recent Developments. Recent Machine-Tool Developments—XXIII, Joseph Horner. Engineering, vol. 112, no. 2919, Dec. 9, 1921, pp. 780–783, 11 figs. Deals with different types of drilling machines.

Sensitive. A New Sensitive Drilling Machine. Eng. Production, vol. 3, no. 61, Dec. 1, 1921, p. 523, 1 fig. Describes machine designed by Adept Eng. Co., Birmingham, England. Work is held in vice of special construction which trips up to diameter of 3 in.

DROP FORGING

Modern Practice. Modern Drop-forging Practice, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 308–312, 7 figs. Notes on trimming forgings; forging heats. Typical examples of drop-forging work.

E

ECONOMIZERS

Feedwater Heaters and. The Selection of Economizers and Feed-Water for Municipal Power-Plants, W. F. Schaphorst. Am. City, vol. 25, no. 6, Dec. 1921, pp. 489–493, 4 figs. Discusses operation of economizers and two types of feedwater heaters.

EDUCATION, ENGINEERING

Early Training. The Education of Engineers, E. A. Allcut. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 633–637. Refers to lack of co-ordination in connection with early training of engineers and points out discrepancies (starting at elementary schools) with view to their ultimate disappearance or modification.

ELECTRIC FURNACES

Gray-Iron Castings. Electric-Furnace Casting in Germany (Elektroofenguss in Deutschland), H. Kölla. Giesserei-Zeitung, vol. 18, no. 28, Oct. 18, 1921, pp. 379–381. Enumerates its advantages for production of gray-iron casting.

Melting and Refining. The Electric Furnace in Melting and Refining, John B. C. Kershaw. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 636–639, 5 figs. Annual review of developments, including modern tendencies in electric-furnace design, the Soderberg electrode, and the Russ electric arc furnace.

Resistance. New Electric Resistance Furnaces for Heat Treating Steel (Nouveaux fours électriques a résistance pour le traitement thermique de l'acier), L'Industrie Électrique, vol. 30, no. 705, Nov. 10, 1921, pp. 405–407, 4 figs. Describes vertical furnace and horizontal continuous furnace developed during war.

Smelting. Smelting Iron Ore Electrically, Frank Hodson. Iron Trade Rev., vol. 69, no. 23, Dec. 8, 1921, pp. 1492–1493. Points out that inexperience and inadequate financing have been responsible for failure of many efforts to place direct processes of steelmaking on practical basis.

ELECTRIC LOCOMOTIVES

Design. Selecting Designs for Electric Locomotives, A. W. Gibbs. Ry. Age, vol. 71, nos. 21 and 22, Nov. 19 and 26, 1921, pp. 987–989, 4 figs. and pp. 1057–1060, 15 figs. Nov. 19: Describes methods used for testing locomotive and discusses electric locomotive drives. Nov. 26: Tests indicate that non-symmetrical wheel arrangement is essential for best performance. (Abstract). Paper read before Franklin Inst.

Freight. Electric Freight-Train Locomotives (Elektrische Güterzuglokomotiven), Karl Trautvetter. Fördertechnik u. Frachtverkehr, vol. 14, nos. 21 and 22, Oct. 14 and 28, 1921, pp. 259–261 and 281–283, 6 figs. Discusses different German types.

Storage-Battery. Storage-Battery Locomotives in Metal Mines, E. V. Daveler and R. E. Renz. Min. & Sci. Press, vol. 123, no. 22, Nov. 26, 1921, pp. 751–752. Describes experience in Butte & Superior mine; provisions for safety; care and service of locomotives. Paper read before Nat. Safety Congress.

ELECTRIC PLANTS

Blackburn, England. The New Blackburn Power Station. Tramway & Ry. World, vol. 50, no. 25, Nov. 17, 1921, pp. 261–264, 8 figs. Describes equipment; two 10,000-kw. turbo-alternators, coal and ash-handling plant, boiler plant, switch gear, etc.

Buenos Aires. The "Dock Sud" Power Station in Buenos Aires, E. Hayn. Eng. Progress, vol. 2, no. 11, Nov. 1921, pp. 247–251, 7 figs. Position and general plan; coal supply; boiler house and engine plant; supply of cooling water; switch gear house.

Hartford Electric Light Co. The Hartford Electric Light Company's South Meadow Station. Power, vol. 54, no. 23, Dec. 6, 1921, pp. 872–882, 14 figs. Equipment arrangement particularly adapted to operating convenience. Plant laid out for 130,000 kw. in five units. Turbine's guaranteed water rate 10.1 lb. per kw-hr. Closed system of generator cooling. Boiler operation centered in boiler-control room.

Industrial Works. A Modern Works Power Plant. Eng. Production, vol. 3, no. 59, Nov. 17, 1921, pp. 469–474, 12 figs. Describes plant installed by Marshall Sons & Co., Ltd. to serve their various works at Gainsborough.

Outdoor Stations. Outdoor Stations (Les sous-stations exterieures), Leon Drin. Révue Générale de l'Électricité, vol. 10, no. 20, Nov. 19, 1921, pp. 717–728, 27 figs. Describes American stations at Tacoma, Newark, N. J., Hastings, and Minneapolis, also some French stations, and their arrangement.

Runcorn, England. New Electric Power Station at Runcorn. Engineer, vol. 132, no. 3440, Dec. 2, 1921, pp. 584–588, 13 figs. partly on p. 596. Site is laid out with view to ultimate output of 100,000 kw. and first installation comprises two 12,500-kw. Parsons turbo-generators supplied with steam from Babcock & Wilcox marine-type water-tube boilers. Supply is on three-phase a.c. system at 440 volts for power and on single-phase a.c. system at 250 volts for lighting, long-distance transmission being carried out at 33,000 volts and short-distance at 6000 and 3000 volts.

Sheffield, England. Electricity Supply in Sheffield. Electrician, vol. 87, no. 2268, Nov. 4, 1921, pp. 566–570, 7 figs. Describes new Blackburn Meadows station; coal and ash handling, boiler house, economizers, feed pumps, generators (four three-phase 50-cycle 6,600 volt two at 1,500 and two at 3,000 r.p.m.), and auxiliaries. See also Elec. Rev. (Lond.), vol. 89, nos. 2293 and 2294, Nov. 4 and 11, 1921, pp. 605–608 and 628–630, 13 figs.; also Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 641–643, 4 figs.

Unit Costs. Unit Costs of New Bedford Generating Station. Elec. World, vol. 78, no. 22, Nov. 26, 1921, pp. 1072–1073, 1 fig. Discusses economical construction and efficient operation of Cannon Street station of Edison Gas & Elec. Light Co. and gives analysis of operating and construction costs.

ELECTRIC WELDING

Science of. The Science of Electric Welding, W. E. Ruder. Jl. Franklin Inst., vol. 192, no. 5, Nov. 1921, pp. 561–583, 24 figs. Notes on carbon electrode arc welding; metallic arc process; metallography of welds; metal transfer; electrodes; reliability of welded joints; electrical characteristics and equipment; automatic arc welding.

ELECTRON METAL

See MAGNESIUM ALLOYS.

ELEVATED RAILWAYS

Hamburg, Germany. Ten Years of the Hamburg Elevated Railway, Wilhelm Mattersdorff. Elec. Ry. Jl., vol. 58, no. 23, Dec. 3, 1921, pp. 879–985, 16 figs. Describes improvements made in recent years and gives operating data.

ELEVATORS

Interlocks, Survey of. Results of a Survey of Elevator Interlocks and an Analysis of Elevator Accident Statistics, C. E. Oakes and J. A. Dickinson. U. S. Bur. Standards Technologic Papers, no. 202, Oct. 17, 1921, 30 pp. Gives results of field survey of several thousand elevator landings equipped with various types of mechanical and electromechanical interlocks and contact devices. Survey was conducted in connection with preparation of elevator safety code in cooperation with engineers of Am. Soc. Mech. Engrs. Statistics show that 73.8 per cent of all fatal accidents might be prevented by well-designed interlocks.

Power for. Continuous Motors and Pneumatic Gear for High-Power Machinery (Durchlaufender Motor und Druckluftsteuerung fur Arbeitsmaschinen grosser Leistung), Franz Jordan. Fördertechnik u. Frachtverkehr, vol. 14, no. 22, Oct. 28, 1921, pp. 271–274, 6 figs. Advantages of continuously over intermittently operating motors for elevators, cranes, etc., are enumerated.

EMPLOYMENT

Continuous, Problem of. The Engineering Approach to the Problem of Continuous Employment, Richard A. Feiss. Bul. Taylor Soc., vol. 6, no. 5, Oct. 1921, pp. 187–194. Deals with problems and importance of stabilization of employment.

EMPLOYMENT MANAGEMENT

Trade Tests. The Value of the Trade Test in Industry, Russell J. Waldo. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 351–357, 7 figs. Shows parts of typical trade tests used by writer with unusual success.

ENGINEERS

Business Methods. Business Methods of European Engineers Compared with Those of American Engineers, Axel Malm. Jl. Engrs.' Club Phila., vol. 38–11, no. 203, Nov. 1921, pp. 389–391. Discusses salesmanship, advertising methods and education of foreign and American engineers.

Training. Training the Engineer for Industrial and Social Service. Eng. News-Rec., vol. 87, no. 24, Dec. 15, 1921, pp. 979–981. Two engineering educators discuss professional and non-professional opportunities of the young engineer and length of course justified in preparing him for service. Projecting Professional Ideas Into Business, by Frederic Bass; Visioning the Opportunity of the Engineer, Hale Sutherland.

ENGINEHOUSES

Cold-Climate. Novel Engine Facilities for a Cold Climate. Ry. Age, vol. 71, no. 22, Nov. 26, 1921, pp. 1049–1051, 2 figs. Describes rectangular engine-house containing turntable, at Hoornepayne, Ont., constructed by Can. Nat. Ry. Co.

F

FACTORIES

Efficiency and Fuel Consumption. Efficiency and Fuel Consumption of Factory Plants (Wirkungsgrad und Brennstoffverbrauch von Fabrikanlagen), Karl Meller. Werkstattstechnik, vol. 15, no. 19, Oct. 1, 1921, pp. 565–575, 18 figs. Investigation shows present efficiency of German plants averages only 30 per cent. Study of conditions on which efficiency depends and measures to be adopted for increasing efficiency and thereby reducing consumption of coal.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS, CENTRIFUGAL

Design. The Design and Construction of Fans—XIII and XIV, F. G. Whipp. Mech. World, vol. 70, nos. 1818 and 1822, Nov. 4, and Dec. 2, 1921, pp. 370–372 and 440–441, 2 figs. Discusses cased fans and calculation of area and pressure; gives table of losses due to friction, design and calculation.

Molding and Machining. Making Centrifugal Fans, G. W. Brown. Machinery (Lond.), vol. 19, no. 479, Dec. 1, 1921, pp. 261–263, 8 figs. Describes molding and machining operations.

FATIGUE

Industrial. Methods of Reducing Fatigue in the Tool Rooms. F. B. and L. M. Gilbreth. Can. Machy., vol. 26, no. 21, Nov. 24, 1921, pp. 33 and 35, 2 figs. Discusses orderly arrangement of tools; shelves; light; etc. From paper read before Soc. Industrial Engrs.

Safety Work and. Fatigue Study: A First Step in Safety Work. Frank B. and L. M. Gilbreth. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 557–558. Authors show how fatigue can prove most useful in safety work, and that same methods and devices at present employed in factories and offices can be used effectively to do both types of work.

FLIGHT

Soaring. The Second Rhön Soaring Flight Contest (Der zweite Rhön-Wettbewerb), Werner v. Langsdorff. Luftfahrt, vol. 25, no. 9, Sept. 1921, pp. 151–156, 13 figs. Part I: Account of flight performances and description of participating machines. Part II: Technical remarks, by Roland Eisenlohr.

FLOORS

Flat-Slab. Calculation of Flat-Slab Floors (Zur Berechnung der Pilzdecke), K. Hruban. Beton u. Eisen, vol. 20, nos. 16 and 17–18, Oct. 5 and Nov. 4, 1921, pp. 187–188 and 200–202, 8 figs. Investigation of calculations heretofore used and description of new method in which variability of height of plate is taken into consideration.

FLOW IN PIPES

Hot Gases. Flow of Hot Gases in Pipes (Expériences très simples au sujet des mouvements des gaz chauds dans des tuyaux), J. Seigle. Révue de l'Industrie Minerale, no. 19, Oct. 1, 1921, pp. 607–611, 10 figs. Describes experiments in connection with circulation of hot gases and smoke in furnaces.

FLOW OF STEAM

Nozzles. Note on the Flow of Air and Steam in Nozzles, Gerald Stoney and Norman Elce. Engineering, vol. 112, no. 2918, Dec. 2, 1921, pp. 750–751. Notes on discharge coefficients which afford evidence that no condensation takes place before throat with wet or saturated steam, and that saturated steam acts down to throat as a perfect gas with adiabatic index of 1.3.

FLUIDS

Properties at Critical Point. Theoretical Study of the Properties of Fluids at About Their Critical Points (Étude théorique des propriétés des fluides au voisinage du point critique), G. Bruhat. Journal de Physique et le Radium, vol. 2, no. 10, Oct. 1921, pp. 303–316, 1 fig. Mathematical rendering of the hypothesis of the continuity of the liquid and gaseous states and properties defining critical point; etc.

FLUE-GAS ANALYSIS

Apparatus. Improvements in Flue-Gas Investigating Apparatus (Neuerungen an Rauchgasuntersuchungsapparaten), H. v. Ihering. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 37 and 38, Sept. 16 and 23, 1921, pp. 291–293 and 299–301, 9 figs. Details and experiences with flue-gas testing apparatus known as Ranarex, and the Moeller-Gerdien flue-gas analyzer constructed by Siemens-Schuckert Works.

Solid and Liquid Fuels. Flue-Gas Compositions for Solid and Liquid Fuels (Rauchgaszusammensetzungen fur feste und flussige Brennstoffe), E. Kraemer. Feuerungstechnik, vol. 10, nos. 1, 3 and 4, Oct. 1, Nov. 1 and 15, 1921, pp. 3–6, 21–25 and 34–37, 7 figs. Charts are developed for rapid testing of flue-gas analyses for fuels, especially coal of variable composition.

FLYING BOATS

Dornier. The Dornier "Dragon Fly" Flying Boat. Flight, vol. 13, no. 42, Oct. 20, 1921, pp. 685–686, 6 figs. Small, low-powered, three-seater monoplane; 50–60-hp. Siemens-Halske engine, 5-cylinder radial air-cooled; almost entirely constructed of metal, especially duralumin. Gives data.

FOREMEN

Training of. How to Educate Foremen, V. M. Palmer. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 321–324. Importance of giving them systematic training and method of accomplishing this.

The Foreman's Place in Industry, Ralph W. Immel. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 340–342, 2 figs. Author claims that object should be not to educate foreman, but to get him to apply knowledge he already possesses. Shows two types of form used by foreman for job analysis.

FORGING

Flow of Metal. The Flow of Metal During Forging, Harold F. Massey. Mech. World, vol. 70, nos. 1820, 1821, and 1822, Nov. 18, 25 and Dec. 2, 1921, pp. 408–410, 424–425 and 444–447, 33 figs. Results of a number of experiments, particularly to study the relation between the action of forging by pressure and by blows. Paper read before Manchester Assn. of Engrs.

FOUNDRIES

Charging Platform. Charging Floor with Undercover Storage, Edwin A. Hunger. Iron Age, vol. 108, no. 23, Dec. 8, 1921, pp. 1459–1462, 7 figs. Details of new foundry and machine shop of Duplex Printing Press Co., Battle Creek, Mich. Notable feature is big charging platform, entirely under cover, with storage capacity for 5000 tons of metal and ten carloads of coke at one time. Raw materials unloaded in single operations. Core making expedited with special cement boxes.

Conveyors for. Decreasing Foundry Costs Through the Mechanical Handling of Materials, J. M. Macrae. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 257–259, 3 figs. Describes application of complete conveyor system installed in the Kelsey Wheel Co. foundry, Detroit, Mich.

Malleable-Iron. The Malleable-Iron Foundry, Its Organization (La fonderie de fonte malléable, son organisation), Christian Kluytmans. La Fonderie Moderne, no. 9, Sept. 1921, pp. 241–253, 14 figs. Gives general plan for foundry and describes the various operations with samples of record cards used for routing work.

Material-Handling Equipment. Solves Material Handling Problems in Design of New Foundry, H. R. Simonds. Iron Trade Rev., vol. 69, no. 24, Dec. 15, 1921, pp. 1545–1549, 10 figs. Electrically controlled cars for raw materials, storage-battery lift trucks for ladles and castings, and monorail system speed operations in new casting plant in Springfield, Mass. Molding floor routine is flexible. Wood block floor used in all operating departments.

Systematizing Production. Systemising Foundry Production. Hubert Bentley. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 631–632, 2 figs. Describes efficient system capable of general application in foundry. Deals with regulation of supply of castings, method of ordering storage, and recording of work in hand.

FOUNDRY PRACTICE

Metal Casting. Problems Involved in Casting Metal, Thomas Turner. Foundry, vol. 49, no. 3, Dec. 1, 1921, pp. 926–933, 6 figs. With good foundry practice sound castings can be obtained from any metal provided there are no reactions which lead to formation and evolution of gas. (Abstract.) Paper read before Inst. of Metals.

FUELS

Economy. A Few Notes on the Fuel Economy Institute (Eenige korte medeelingen over het Instituut voor Brandstoffeneconomie), F. C. J. M. Wirtz. Ingenieur, vol. 36, no. 46, Nov. 12, 1921, pp. 905–907. Reviews similar organizations in other countries and describes scope of Dutch Institute.

Research. Fuel Research Developments, C. F. Kettering. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 291–296 and 343–344, 15 figs. Discusses multi-cylinder distribution and chemical constitution of mixtures, anti-knock substances, ignition point, future fuel research, etc.

Sawdust. Sawdust Burned with Aid of Steam Jets. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 914–917, 3 figs. Large industrial plant at Cleveland, Ohio, burns both sawdust and coal under same boilers. Automatic control speeds up stokers when sawdust supply becomes low.

Smokeless. Low Temperature Carbonisation. Eng. & Indus. Management, vol. 6, no. 16, Oct. 20, 1921, p. 445. Describes new retorts patented by Low Temperature Carbonisation, Ltd., Baruch, England, by means of which, it is claimed, production of smokeless fuel, "coalite," together with all valuable by-products, is now a commercial proposition.

[See also PULVERIZED COAL.]

FURNACES, BOILER

Gas-Fired. The Continuous Thermotechnical Control of Gas Firings in Metallurgical Plants (Die fortlaufende wärmetechnische Ueberwachung der Gasfeuerungen in Huttenbetrieben), Hermann Wolf. Stahl u. Eisen, vol. 41, no. 45, Nov. 10, 1921, pp. 1611–1614, 5 figs. Details of two measuring houses and equipment, one, for continuous control of boiler plant and the other for control of blast supply.

Heat Conservation. Thermotechnology of Boiler Furnaces (Wärmetechnisches von Dampfkesselfeuerungen), H. Schulte. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 40, Oct. 7, 1921, pp. 319–324, 4 figs. Deals with use of low-grade fuels; mechanical draft; furnace losses; mechanical stokers; traveling grates, etc.

Lining. Lining Fire Boxes With Refractory Brick (Revestimiento de hogares con ladrillos refractarios), James F. Hobart. Ingenieria Internacional, vol. 6, no. 6, Dec. 1921, pp. 354–356, 4 figs. Discusses lining of various kinds of boiler furnaces.

Turbine Patent. The Turbine Patent Furnace. Eng. Production, vol. 3, no. 60, Nov. 24, 1921, pp. 489–490, 4 figs. Details of forced-draft unit for boilers.

Wood-Waste-Fired. Novel Boiler Installation for Burning Wood Refuse. C. W. Smith. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1196–1197, 5 figs. Gases from separate Dutch oven furnace are conducted through tunnel to stoker furnace and boiler.

FURNACES, HEATING

Automatic Grates. Automatic Grates and Their Application in High-Temperature Combustion Chambers (Les grilles automatiques dans leurs applications aux chambres de combustion a haute température), F. Verdeaux. La Technique Moderne, vol. 13, no. 10, Oct. 1921, pp. 414–417, 3 figs. Discusses heating furnaces in particular; relation between temperature at fire bridge and fuel consumption; operations at high temperatures.

FURNACES, HEAT-TREATING

Springs. Furnaces for Heat Treatment of Springs. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 568–572, 18 figs. Stationary and continuous furnaces; types and arrangement.

FURNACES, HOT-AIR

Testing. Air Measurement in Furnace Testing, A. C. Willard, A. P. Kratz and V. S. Day. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 797–812, 11 figs. Describes air-weighing plant for calibration purposes, and the Wahlen gage for measuring small air pressures.

FUSION WELDING

Steel. The Fusion Welding of Steel, S. W. Miller. Iron Trade Rev., vol. 69, nos. 21 and 22, Nov. 24 and Dec. 1, 1921, pp. 1346–1349 and 1422–1426, 17 figs. Advantages and limitations of oxy-acetylene, electric and thermit processes. Low-carbon steel best adapted to welding. (Abstract.) Paper presented at Am. Iron & Steel Inst.

G

GAGES

Circular, Allowances with. Compound Allowance Systems and the Economical Selection of Gages with Circular Allowances (Verbundpassungssysteme und wirtschaftliche Lehrenauswahl bei Rundpassungen), K. Gottwein. Werkstattstechnik, vol. 15, no. 19, Oct. 1, 1921, pp. 579–584, 21 figs. Discusses general properties of compound systems which, with comparatively few gage classes, attain many classes of fits.

Go and Not-Go. The Need of Gauging for Modern Manufacturing, A. C. Wickman. Can. Machy., vol. 26, no. 17, Oct. 27, 1921, pp. 33–36, 3 figs. Discusses limits in the tapped hole, go and not-go gages, limit of microscopic magnification.

GAS ENGINES

Manufacture. Famous British Works. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, pp. 434–435, 4 figs. Describes works of the Campbell Gas Engine Co., Ltd., Kingston, Halifax.

Schneider. Notes on the Schneider Gas Engine, H. A. A. Dombrain. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 643–646, 4 figs. Made in four types, viz., single cylinder, twin single cylinder, tandem, and twin tandem, the last giving as high as 6,000 hp. They are all horizontal and four stroke.

Wood-Refuse Suction. 400-Hp. Wood Refuse Suction Gas Engine. Engineer, vol. 132, no. 3438, Nov. 18, 1921, p. 547, 4 figs. partly on p. 540. Details of engine to work on gas derived from producer fired with wood refuse. It has four cylinders, each 17-in. diam. by 24-in. stroke.

GAS PRODUCERS

Calculations of Gas in. Calculations Regarding Gas in Gas Generator With Steam Added to Air Blowing (Calculs comparatifs au sujet des gaz de gazogène, dans le cas d'addition de vapeur d'eau a l'air soufflé), J. Seigle. Révue de Métallurgie, vol. 18, no. 9, Sept. 1921, pp. 608–618, 7 figs. Discusses calorific power per cubic meter, calorific power of the volume of gas from 1 kg. of coal, etc.

Central. Ten Years' Experience with Central Producer Plant in the Municipal Gas Works of Vienna (10 Jahre Zentralgeneratorenbetrieb in den Wiener städtischen Gaswerken), Ernst Kaudela and Josef Pretsch. Gas- u. Wasserfach, vol. 64, no. 37, Sept. 10, 1921, pp. 601–606, 3 figs. Advantages of central producers are summarized.

Ebelmen. The Fused Ash Gas Producer (Le gazogène à fusion des cendres), A. Fichet. Le Génie Civil, vol. 79, no. 16, Oct. 15, 1921, pp. 329–332, 2 figs. Describes Ebelmen system principally, also the Rehmann system.

Lignite Briquets for. Using Lignite Briquettes in Gas Generators (Essais d'utilisation de briquettes de lignite pour le chauffage de fours à gazogène), De Groote. Chaleur et Industrie, vol. 2, no. 18, Oct. 1921, pp. 661–666. Describes favorable experiments with a battery of three Morgan generators; composition of briquettes used, heat balance, ash, composition of gas, etc.

Pulverized-Coal. Producers for Pulverized Coal (Kohlenstaubvergaser), H. Gwosdz. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 38, Sept. 23, 1921, pp. 297–299, 2 figs. Discussion of Marconnet and Hirt types and possibilities of improvements.

GEARS

Helical. Cutting Helical Gears on Automatic Machine, H. A. Wilson. Can. Machy., vol. 26, no. 19, Nov. 10, 1921, pp. 29–33, 13 figs. Various operations on automatics, including making of stud; dust cap cutting helical gears; chart showing tools used; machine equipped with rear end threading attachment.

Herringbone. Double Helical or Herringbone Gears, Howard H. Talbot. Iron Age, vol. 108, nos. 23 and 24, Dec. 8 and 15, 1921, pp. 1469–1473 and 1531–1533, 17 figs. Dec. 8: Elements of design to combine adequate strength with smooth and continuous action and minimum of friction of contact surfaces. Dec. 15: Use of long addenda in pinion and short addenda in driven gear, to increase the "follow through."

Maag. Maag Gearing, L. J. Le Mesurier. Engineering, vol. 112, no. 2919, Dec. 9, 1921, pp. 801–805, 20 figs. Describes system of gearing and methods of production developed by Maag Gear Co., Zurich, Switzerland, with which means have been found which enable straight-tooth spur gears to be employed successfully under conditions demanding highest possible peripheral speeds and loads per unit width of tooth. Describes entirely novel grinding process. (Abstract.) Paper read before North-East Coast Instn. Engrs. & Shipbuilders.

GRINDING

Milling vs. Milling Versus Grinding (Fräsen oder

Schleifen-). Carl Krug. Werkstatttechnik, vol. 15, no. 19, Oct. 1, 1921, pp. 575–576. Presents table showing relative working conditions with milling and grinding machines, showing economy of latter.

Steel Billet. Modern Method of Steel Billet Grinding, R. H. Cannon. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 557–559, 3 figs. Advantages of grinding over chipping in relation to wheel cost, labor cost and overhead. Making grinding wheel test.

H

HANDLING MATERIALS

Factories. An Organized Transportation Department, John A. MacCrea. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 327–329, 4 figs. Describes briefly organization and principal features of operation of department for moving of material.

Trucks as Conveyors. Making the Truck an Asset in Management, Edward H. Tingley. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 267–271, 9 figs. How special types may be used to save floor space, provide effective storage and minimize moving time between operations.

Waste Elimination. Material Handling an Important Factor in the Elimination of Industrial Waste, H. V. Coes. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 803–804 and 825. Points out opportunities in almost every branch of industry to reduce large wastes in material handling. Examples of savings effected, and how to arrive at best method.

HANGARS

German Airship. Large German Airship Stations, J. Sabatier. Aerial Age Weekly, vol. 14, no. 6, Oct. 17, 1921, pp. 128–130. Discusses general plans, construction details, hangar accessories, maneuvering fields, hydrogen works, etc. Translated from L'Aeronautique.

HARDNESS

Measurement of Steel Balls. Schleroscope Hardness of Steel Balls, Arthur L. Collins. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1391–1393, 5 figs. Widely varying results on different sizes. Explanation of cause and suggested remedy.

Testing. The Hardness Testing of Metals. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, pp. 436–440, 11 figs. Discussion of modern methods. (Abstract). Progress report of Committee of Eng. Div. of U. S. Nat. Research Council.

The Use of the Scleroscope on Light Specimens of Metals, Fred S. Tritton. Metal Industry (Lond.), vol. 19, no. 19, Nov. 4, 1921, pp. 361–364, 4 figs. Describes experiments undertaken to find out whether errors existed when using ordinary methods of support, and, if so, to find some method of support that would eliminate them.

HEAT TRANSMISSION

Air Spaces. Air Space Transmission, Percy Nicholls. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 783–790, 3 figs. Includes abstract of paper by H. C. Dickinson and M. S. Van Dusen on the testing of thermal insulators, and presents table prepared by Bur. of Standards, separating values for radiation and convection.

HEATING, ELECTRIC

Development, Switzerland. The Development of Electric Heating in Switzerland (Die Entwicklung der elektrischen Heizung in der Schweiz). Gesundheits-Ingenieur, special no., July 1921, pp. 18–27, 15 figs. Describes arrangements developed by Sulzer Bros., Winterthur, Switzerland, in reconstruction of existing hot-water installations, steam and hot-water central-heating plants for use of electricity.

Hot-Water. The Electric Pumping Hot-Water Heating System in the Repair Shop for Electric Locomotives of the Swiss Federal Railway in Bellinzona (Die elektrische Pumpen-Warmwasserheizung in der Reparaturwerkstätte für elektrische Lokomotiven der Schweiz. Bundesbahnen, in Bellinzona). Schweiz. Elektrotechnischer Verein Bul., vol. 12, no. 10, Oct. 1921, pp. 270–274, 4 figs. Describes electric heating installation believed to be largest of its kind.

HEATING, FACTORY

Ventilation and. Heating and Ventilation of Factories, H. H. Angus. Contract Rec., vol. 35, no. 50, Dec. 14, 1921, pp. 1085–1088. General outline of principles involved and methods adopted to maintain satisfactory working temperatures and atmospheric conditions. Paper before Toronto Branch Am.Soc.Mech.Engrs.

HEATING, STEAM

Central-Station. The Economy of Large Central Heating Plants (Ueber die Wirtschaftlichkeit grosser Fernheizungsanlagen). Gesundheits-Ingenieur, special no., July 1921, pp. 27–32, 8 figs. Based on operating results in two Westphalian provincial sanitariums.

HELIUM

Airships. Helium for Airships. Aviation, vol. 11, no. 22, Nov. 28, 1921, p. 635. Discusses available supply, cost of production, repurification plant, etc.

HYDRAULIC TURBINES

Breakdown. Investigation of Breakdown of 30,000-Kw. Turbine. Power, vol. 54, no. 21, Nov. 22, 1921, pp. 788–793, 13 figs. Account of accident in Schuylkill plant of Philadelphia Elec. Co. and conclusions from investigation. Points out that abrupt changes of section and formation of sharp angles in design of bucket wheels should be avoided.

Design. Certain Features Relating to Hydraulic Turbine Design and Settings, E. W. Burbank. Proc. La. Eng. Soc., vol. 7, no. 4, Aug. 1921, pp. 150–173, 8 figs. Discusses formulas and terms used, reaction and impulse types of turbines and their operation.

Efficiency. Influence of Turbine Efficiency on Yield of Hydroelectric Plants (Einfluss des Turbinen-Wirkungsgrades auf den Ertrag von Wasserkraftanlagen), H. Leiner. Elektrotechnische Zeit., vol. 42, no. 39, Sept. 29, 1921, pp. 1089–1093. Equations are developed for determination of efficiency of turbines from economical and technical viewpoint.

Impulse. Largest Impulse Turbine Units in Caribou Station, W. M. White. Power, vol. 54, no. 24, Dec. 13, 1921, pp. 923–926, 7 figs. Two of largest impulse-wheel-driven units in world, rated at 30,000 hp. each and operating under 1008-ft. heat at 171 r.p.m. have been installed. Unit consists of two independent wheels, one on either side of generator.

Sand-Removing Plant. Wear in Hydraulic Turbines and How to Avoid It (L'usure des turbines hydrauliques, ses consequences et les moyens d'y parer), H. Dufour. Bulletin Technique de la Suisse Romande, vol. 47, no. 22, Oct. 29, 1921, pp. 253–256, 6 figs. Describes sand-removing plant at Monthey works of Societé pour l'Industrie Chimique à Bâle.

HYDROELECTRIC DEVELOPMENTS

Dutch East Indies. Water Power Construction Work and Prospects in the Dutch East Indies (Verrichtingen en verwachtingen op waterkrachtgebied in Ned.-Indië), A. Groothoff. Ingenieur, vol. 36, no. 48, Nov. 26, 1921, pp. 945–953, 17 figs. Discusses resources and plants in Java, Sumatra, Borneo and Celebes.

Queenston-Chippawa. The Chippawa-Queenston Power Canal. Can. Engr., vol. 41, no. 23, Dec. 8, 1921, pp. 1 and 10, 6 figs. Big Ontario power development practically completed. Canal is 12½ mi. long with max. depth of 145 ft.; available gross head, 315 ft.; width of concrete section, 48 ft.; depth of water, 35–40 ft.; total earth excavation, 13,299,000 cu. yd.; total rock excavation, 4,182,000 cu. yd.; max. capacity of each turbine, 60,000 hp.; total weight of each complete generating unit, 1,853,000 lb.

St. Lawrence River. Hydro Report on St. Lawrence River. Can. Engr., vol. 41, nos. 21, 22, 23 and 24, Nov. 24, Dec. 1, 8 and 15, 1921, pp. 1, 4–5; pp. 1,4, 5, 9 and 10, 5 figs.; pp. 4–5; and 9–10. Suggests three alternative schemes for power development and gives cost of each. Study of physical conditions. Ontario Hydroelectric Commission's engineering report to Int. Joint Commission.

The St. Lawrence Power Development. Can. Engr., vol. 41, no. 22, Dec. 1, 1921, pp. 1, 10, 11 and 12, 4 figs. Salient features of report by Hugh L. Cooper to Int. Joint Commission on navigation and power in St. Lawrence River. Recommends Croil Island as site for main dam and power plant.

Seattle, Wash. Progress on the Skagit River Power Project. Eng. News-Rec., vol. 87, no. 23, Dec. 8, 1921, pp. 948–949, 3 figs. 23-mi. railroad and construction power plant completed in Seattle. Work on 2-mi. main tunnel is under way.

World. Hydro-Electric Developments—II and III, F. Rowlinson. Beama, vol. 9, nos. 4 and 5, Oct. and Nov. 1921, pp. 351–359 and 451–458, 3 figs. Oct.: Discusses undertakings in Scandinavia, Canada, Australia, India, Switzerland, Spain, Italy, etc. Nov.: Developments in Austria, United States, Sweden and Formosa.

HYDROELECTRIC PLANTS

Lausanne, Switzerland. Electric Plants of the Town of Lausanne (Les installations électriques de la ville de Lausanne), M. Cauderay. Bulletin Technique de la Suisse Romande, vol. 47, nos. 19 and 21, Sept. 17 and Oct. 15, 1921, pp. 217–223 and 241–248, 16 figs. Describes reservoirs, conduits, canals, turbines, electrical installations, etc., in connection with hydroelectric plant and its enlargement.

220,000-Volt. First 220,000-Volt Station Completed. Elec. World, vol. 78, no. 23, Dec. 3, 1921, pp. 1115–1119, 12 figs. Describes Big Creek No. 8 Station built by Southern Cal. Edison Co.; has 22,500 kw. vertical reaction turbine; lines are operated at 150,000 volts and will be at 220,000 volts ultimately.

I

INDUSTRIAL MANAGEMENT

Assembling Methods. Saving Time in Assembling, Albert A. Dowd and Frank W. Curtis. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 296–300, 6 figs. Examples showing savings resulting from investigation of assembling methods.

Executive Control Charts. Comparability of Executive Control Charts, Arthur R. Burnet. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 283–288, 7 figs. Fundamental requirement of the "Z" chart and how it may be secured.

Factory Investigations. How Factory Investigations Reduce Costs. Machinery (Lond.), vol. 19, no. 476, Nov. 10, 1921, pp. 149–154, 7 figs. Discusses handling of materials, inspection and salvage, manufacturing a fly-wheel pulley, savings effected by use of punch press, etc.

Financial Control. The Parallel Line of Control in Business, Frederic H. Leland. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 348–350, 1 fig. Points out that there are two scales of parallel lines of business control, a major scale, which shows correctly amount of money involved in principal activities of business; and minor scale which shows money involved in greater detail than is shown on major scale.

Financial Leaks. Seven Leaks We Have Stopped, A. H. Cubberley. Factory, vol. 27, no. 6, Dec. 1921, pp. 743–747, 2 figs. Analysis of principal financial leaks and how to stop them. Practice at E. I. du Pont de Nemours Co. works.

Future of. Scientific Management—XXXIII, Henry Atkinson. Eng. & Indus. Management, vol. 6, no. 19, Nov. 10, 1921, pp. 529–531. Future of scientific management. (Concluded.)

Gantt Charts. The Gantt Chart—IV, Wallace Clark. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 279–282, 3 figs. Its application to plant load.

Improved Methods. Exhibit by the Siemens-Schuckert Works of Practical Examples of Scientific Management (Die Siemens-Schuckertwerke auf der Betriebstechnischen Wanderausstellung), C. W. Drescher. Betrieb, vol. 4, nos. 1 and 2, Oct. 8 and 22, 1921, pp. 1–9 and 11–14, 16 figs. Examples of improvements of working methods by use of up-to-date tools, time and motion studies, standards for cutting tools, toolroom organization, comparison of separate and belt electric drive. Psychotechnical adaptability tests.

Managers, Training. What Constitutes a Good Manager?, N. H. Daniels. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 329–332. How a large engineering firm trains men to deal successfully with public.

Measuring Effectiveness. Measuring the Effectiveness of Management, William B. Ferguson. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 335–340, 1 fig. Study of proportions management resources as: Organization 35 per cent, technical 20 per cent, utilization 45 per cent.

Planning Department. Fundamental Principles for Modern Workshop Precalculation (Unterlagen fur moderne Werkstattvorkalkulation), R. Wiekop. Betrieb, vol. 4, no. 2, Oct. 22, 1921, pp. 29–39, 11 figs. Practical recommendations for job analysis. A new premium system.

Planning in Large Contract Plants, George H. Shepard. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 268–270, 1 fig. Organization of department for planning progress of work through shop.

Production Control. Humanizing Production Control, Howell B. May. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 341–344. How new spirit of team-work in industry is being put in practice. Explains idea of cooperative inter-relationship in factory for purpose of educating foremen and workers and giving ambitious ones an opportunity to advance.

Production, Fluctuation in. Applying "Moving Average" Charts to Industry, A. L. DeLeeuw. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 343–348, 9 figs. Discusses fluctuation in production and how it is reduced.

Production Methods. Modern Production Methods—XXIV, W. R. Basset. Am. Mach., vol. 69, no. 24, Dec. 8, 1921, pp. 950–955, 7 figs. Setting piece rates. Points out that incentive factor is as important as securing results for wage given. Examples of rate derivation. Why piece rates should not be cut.

Productive Ways and Means, H. Darbyshire. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 618–621, 4 figs. Writer deals with number of essential details with which management and supervising staff of any industrial organization should become familiar.

Progress Department. Estimating and Handling Output of "Modifications." Eng. & Indus. Management, vol. 6, no. 21, Nov. 24, 1921, pp. 601–603. Describes progress organization of factory, where, although lines are standardized and produced upon more or less repetition basis, these lines may be modified time and again to meet specific requirements of customers.

Record Sheets. Systematizing and Control of Workshop Jobs (Systematisierung und zwanglaufige Kontrolle von Werkstatt-Auftragen), Carl Redtmann. Der praktische Maschinen-Konstrukteur, vol. 54, no. 36, Sept. 8, 1921, pp. 289–292, 8 figs. Describes record sheet system for carrying out workshop jobs used successfully in machine factory employing 400 to 500 workers.

Workpiece Record Cards (Die Operationslaufkarte), A. Roth. Betrieb, vol. 4, no. 2, Oct. 22, 1921, pp. 44–48, 9 figs. Discusses use of record sheets in machine construction on which all necessary operating data are recorded and which accompany workpiece through all operating stages until delivery into stockroom.

Records for Electrical Department. Efficient Record System for Industrial Electrical Department, J. Elmer Housley. Elec. World, vol. 78, no. 21, Nov. 19, 1921, pp. 1015–1018, 1 fig. Gives forms for motors, lamps, trucks, etc., and describes how to use them.

Simplification. Why We Invested $7,000,000 in "Simplification," Harvey S. Firestone. Factory, vol. 27, no. 6, Dec. 1921, pp. 739–743, 8 figs. Describes policy, developed into specific plan, which has eliminated manufacturing wastes, cut labor costs 20 per cent, and improved quality of product.

Storing Materials. Management Problems of the Small Factory, Ernest Cordeal. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 334–340, 7 figs. How materials are effectively handled and stored.

Toolroom Organization. Organising Tool Production. Eng. Production, vol. 3, no. 59, Nov. 17, 1921-

pp. 462–466, 15 figs. Procedure in the works drawing office and toolroom.

[See also TIME STUDY.]

INDUSTRIAL ORGANIZATION

Engineering Department. Organization of an Engineering Department, W. E. Irish. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 357–361, 1 fig. Author shows plan of organization found suitable to requirements of large steel company and gives account of its working.

Knitting Mills. The Organization of Knitting Mills, Carle M. Bigelow. Management Eng., vol. 1, nos. 5 and 6, Nov. and Dec. 1921, pp. 261–265, 7 figs. and pp. 359–364, 6 figs. Nov.: Standardizing physical conditions. Deals with plant layout and routing. Dec.: Standardizing control of material.

INDUSTRIAL RELATIONS

Construction Industries. Development of Satisfactory Relationship Between Employer and Employe in Construction Industry, Ernst T. Trigg. Eng. & Contracting, vol. 56, no. 21, Nov. 23, 1921, pp. 479–481. (Abstract). Paper presented before joint meeting of Acad. Political Sci. and Am. Indus. Relations Assn. See also Contract Record, vol. 35, no. 47, Nov. 23, 1921, pp. 1021–1023.

Human Factor. The Human Factor in Industry—III, Clarence H. Northcott. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 363–369. Deals with psychology, instincts and tendencies of worker.

Open-Shop Foundry. The Transition to an Open-Shop Foundry, Paul R. Ramp. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1395–1398. Methods used with success in training molding-machine workers, with view to increased output.

Training Executives. Training the Industrial Relations Executive, Edward S. Cowdrick. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 329–330. Notes on college courses in industrial relations.

Works Council. Industrial Democracy in Great Britain, Clarence H. Northcott. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 295–297. Deals with establishment of a works council; qualifications for membership and voting; and how council is organized.

INSPECTION

Systems. Inspectors' Reports, Examples and Methods. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 570–573. Discussion of certain systems of inspection, with view to demonstrating their efficiency under given conditions.

INTERNAL-COMBUSTION ENGINES

Marine. Internal Combustion Engines in Marine Service—II, Charles Edward Lucke. Jl. Am. Soc. Mar. Draftsmen, vol. 8, no. 3, Oct. 1921, pp. 47–57, 10 figs. Compares new standards of turbine steamer and motorship machinery. Paper read before Franklin Inst.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Electrodeposition of. The Industrial Future of Electro-Deposited Iron, W. E. Hughes. Chem. Age (Lond.), vol. 5, no. 124, Oct. 29, 1921, pp. 521–523, 4 figs. Discusses results of research work and microscopic examination of structure of deposited iron. Sees good future for its application.

Electrolytic. Commercial Production of Electrolytic Iron, C. P. Perin and Donald Belcher. Min. & Metallurgy, no. 180, Dec. 1921, pp. 17–18, 2 figs. Describes French process consisting of electrolyzing a concentrated solution of ferrous chloride at temperature of 75 deg. cent. Anodes are of cast iron, cathode is a rotating mandrel of steel. With this process tubes and sheets of any desired gage can be made.

IRON AND STEEL

Chemical Industries, Relations to. Relations of the Iron and Steel and Chemical Industries, James M. Camp. Iron Age, vol. 108, no. 21, Nov. 24, 1921, pp. 1329–1331, 1 fig. Notes on chemicals consumed by steel makers; steel used by chemical plants; role of by-products from coke. Paper read before Am. Iron & Steel Inst.

Sweden. The Swedish Iron and Steel Industry. Raw Material, vol. 4, no. 10, Oct. 1921, pp. 344–348, 8 figs. Historical review of its development.

IRON, PIG

Calculating Foundry Value of. Calculating a Foundry Iron Value, Y. A. Dyer. Iron Age, vol. 108, no. 24, Dec. 15, 1921, pp. 1547–1548. Unit valuation of elements in foundry pig irons. Silicon, manganese and phosphorus considered as metalloids. Carbon and sulphur grouped as Fe.

L

LABOR

Classes to be Avoided. Three Classes of Labor to Avoid, H. A. Haring. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 370–373. Discusses prejudices and habits displayed by men in certain occupations, and describes effects of certain classes of employment upon individual's fitness for modern industrial work.

LATHE TOOLS

Automobile Forgings. Cost-reducing Tooling Equipments, Ralph E. Flanders. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 301–305, 13 figs. Employed for machining steering knuckles and other automobile forgings at high rate of production.

LATHES

Automatic. The Pratt & Whitney Automatic Lathe. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 282–284, 6 figs. Equipped with headstock, tailstock, magazine for holding work, and automatic work-handling and control mechanism.

Automobile Work on Turret. Automobile Production Work on Turret Lathes, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 261–264, 7 figs. Time-saving and cost-reducing methods developed for use in engine department of motor-car plant.

Large. The Evolution of the Large Lathe. British Machine Tool Eng., vol. 1, no. 12, Nov.-Dec. 1921, pp. 413–419, 9 figs. Discusses development of T. Shanks & Co.'s type of lathes to the present 123-in. center double-bed type, which swings 18 ft. 6 in. diameter over saddles.

Turret. "Apollo" 2¾-In. Hollow Spindle Turret Lathe. Engineering, vol. 112, no. 2918, Dec. 2, 1921, pp. 758–759, 29 figs. partly on supp. plate. Details of new model of hollow-spindle or bar lathe brought out by Pollock & Macnab, Ltd., having a hollow spindle, 3⅛ in. in internal diam., intended for work 2¾ in. in diam. and up to 36 in. in length. Heating of centers is 9½ in. and length of bed 8 ft. 9 in.

LIGHTING

Industrial. Good Lighting Increases Production, J. M. Hickerson. Indus. Management, vol. 62, no. 6, Dec. 1921, pp. 325–328, 2 figs. Summary of major facts brought out by survey of industrial lighting conditions.

Illuminating Engineering: The Future Field, J. H. Asdell. Eng. & Indus. Management, vol. 6, no. 16, Oct. 20, 1921, pp. 441–444. Practical notes on planning an efficient scheme of lighting for industrial purposes, together with simple formula for calculation of illumination in general practice.

Metal-Working Plants. Lighting Metal-Working Plants to Increase Production, A. L. Powell. Elec. World, vol. 78, no. 22, Nov. 26, 1921, pp. 1069–1072, 7 figs. Proper intensities, spacings and fixtures for benches, machine tools, sheet-metal work, assembling, painting, etc.; general or "localized-general" system of illumination is satisfactory in most cases.

LIQUIDS

Combustible, Atomizers for. Atomizers for Combustible Liquids (Sui polverizzatori del combustibile liquido). L'Industria, vol. 35, no. 17, Sept. 15, 1921, pp. 389–390, 6 figs. Describes apparatus with four orifices; gives table of pressures and oil atomized.

LOCOMOTIVES

Air Tanks. Fabricating Tanks From Heavy Plate, C. E. Lester. Boiler Maker, vol. 21, no. 11, Nov. 1921, pp. 313–315, 2 figs. Air locomotive tanks built for 800-lb. pressure fitted with special heads.

Belgian. Belgian State Railway Locomotives Type 33 (Locomotives type 33 etat Belge), O. Lepersonne. Revue Universelle des Mines, vol. 11, no. 2, Oct. 15, 1921, pp. 176–181, 3 figs. A compound, four-cylinder, superheater, 2–6–2 locomotive; tractive effort 12,500 kg. Data and description.

Caledonian Railway. Recent Locomotive Practice on the Caledonian Railway, E. C. Poultney. Engineer, vol. 132, nos. 3436 and 3437, Nov. 4, and 11, 1921, pp. 474–476, and 499–500, 9 figs. partly on supp. plate and p. 501. Describes four new classes of locomotives, comprising engines for passenger and goods traffic as follows: Passenger service—outside-cylinder six-coupled, 4–6–0 type; inside-cylinder four-coupled, 4–4–0 type; outside-cylinder six-coupled side-tank engines, 4–6–2 type. Goods service—inside-cylinder six-coupled, 0–6–0 type.

Feedwater Heating. Feedwater Heaters for Locomotives (Speisewasservorwärmer), H. Günther. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 47, Nov. 19, 1921, pp. 1205–1209, 12 figs. Describes heaters with special closing of headers for high water velocities and a live by-pass valve for prevention of cold feeding. Operating experiences with scale formation and elimination. Experimental results with new, cleaned and heavily incrusted heaters.

Feedwater Treatment. Water Treatment From an Investment Standpoint, L. F. Wilson. Ry. Rev., vol. 69, no. 19, Nov. 5, 1921, pp. 602–604. Discusses external and internal treatment of locomotive feedwater.

Fuel Consumption. The Effect of Grade on Locomotive Coal Consumption, George S. Chiles. Ry. Rev., vol. 69, no. 22, Nov. 26, 1921, pp. 715–719, 2 figs. Actual operation of modern equipment illustrates influence of ascending and descending grades.

Hornblocks, Machining. Machining Locomotive Hornblocks. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, p. 451, 4 figs. Describes operation on horizontal milling machine.

Missouri Pacific R. R. New Mountain, Pacific and Switching Locomotives for the Missouri Pacific Railroad. Ry. & Locomotive Eng., vol. 34, no. 9, Sept. 1921, pp. 242–244, 3 figs. Built by American Locomotive Co. 0–6–0 type switching engines: tractive power, simple, 39,100 lb.; working pressure 100 lb. 4–8–2 mountain type engines: tractive power, simple, 53,500 lb.; working pressure, 210 lb. 4–6–2 Pacific type engines: tractive power, simple, 39,500 lb.; working pressure, 193 lb.

Modern Design. Modern Locomotive Engine Design and Construction—LXXV. Ry. Engr., vol. 42, no. 502, Nov. 1921, pp. 421–424 and 439, 3 figs. Discusses coupling-rod design and construction, coupling-rod stresses, etc.

Oil-Burning. The Lentz Hydraulic Drive for Heavy-Oil Locomotives (Das Flüssigkeitsgetriebe von Lentz für Schweröllokomotiven), H. Wittfeld. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 45, Nov. 5, 1921, pp. 1160–1163, 4 figs. Discusses efforts heretofore made for rendering internal-combustion engines for heavy oil feasible for locomotive drive with aid of the Lentz hydraulic drive; and gives operating results with trial of first heavy-oil locomotive with such drive.

Steam Production and Use. On the Question of Economic Production and Use of Steam on Locomotives, G. J. Churchward. Bul.—Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1527–1538, 1 fig. Abstract of replies to questions on superheated steam, superheater engines and non-superheater engines, feedwater treating, and special arrangements, water-tube boilers, etc. Appendix describing Riegel water-tube locomotive boiler.

Steam-Turbine. An Early Steam Turbine Locomotive. Engineering, vol. 112, no. 2917, Nov. 25, 1921, p. 728, 4 figs. on p. 730. Details of Belluzzo steam-turbine locomotive constructed in 1908 by Societa Anonima Officine Mecanniche, Milan, and recently dismantled.

The Zoelly Steam-Turbine Locomotives with Use of Condensation (Zoelly-Dampfturbinen-Lokomotive mit Kondensation). Glasers Annalen, vol. 89, no. 8, Oct. 15, 1921, pp. 88–89, 2 figs. Describes steam piston locomotive built for Swiss Federal Railway. In front of smokebox two enclosed turbines are installed, one for running forward and the other for running backward. Advantages: Saving of at least 20 per cent of coal; elimination of scale formation through use of condensed feedwater, thus considerably increasing life of boiler and reducing cost of operation; insensibility of steam turbine to highly superheated steam.

Stoker-Fired. The Locomotive Stoker As An Operating Factor, Frank P. Roesch. Ry. Rev., vol. 69, no. 21, Nov. 19, 1921, pp. 685–687. How stoker-fired locomotives can be operated to obtain maximum operating efficiency with minimum expense.

Performance of the Hanna Locomotive Stoker on the Norfolk & Western Railway. Ry. & Locomotive Eng., vol. 34, no. 11, Nov. 1921, pp. 308–310, 1 fig. Describes special trial trips showing efficiency of this stoker. Particulars of firebox conditions, etc.

Superheater. Superheater Practice in American Locomotives. Boiler Maker, vol. 21, no. 11, Nov. 1921, pp. 301–305, 12 figs. Describes most successful methods developed for handling superheater work by railroads.

Transportation without Dismantling. Locomotives for Belgian State Railways. Ry. Gaz., vol. 35, no. 19, Nov. 4, 1921, pp. 690 and 697, 5 figs. partly on pp. 691–692. Describes arrangements by Armstrong, Whitworth & Co. for delivering locomotives to Belgium without dismantling for transport.

Trucks. On the Question of Bogies (Trucks), Axle and Springs of Locomotives, George Hughes. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1589–1674, 84 figs. Includes appendixes containing tabular statements on kinds of bogies used by various companies, method of fixing springs for driving and coupled wheels, springing, cylinders, heating surfaces and particulars of two-wheel trucks.

2-8-2 Mikado. 2–8–2 Type Locomotives for the Nickel Plate. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 737–738, 4 figs. Design based on U.S.R.A. light Mikado with improvements in details. Booster handles 22 per cent additional tonnage.

2-10-2 and Pacific Types. American Locomotives for the Philippines. Ry. Rev., vol. 69, no. 23, Dec. 3, 1921, pp. 756–769, 11 figs. Describes 2–10–2 and Pacific-type locomotives delivered by American Locomotive Co. to Manila Railroad; tractive effort 35,700 and 28,600 lb.

LUBRICATING OILS

Capillary Properties. Testing of Lubricants for Determination of Their Capillary Properties (Zur Schmierölprüfung auf die kapillaren Eigenschaften der Schmiermittel), Richard von Dallwitz-Wegaer. Petroleum, vol. 17, nos. 24 and 25, Aug. 20 and Sept. 1, 1921, pp. 849–854 and 885–887, 4 figs. Demonstrates necessity, when testing oils, of investigating their capillary properties and describes apparatus therefor.

Recovery from Anthracite Tar. The Recovery of Viscous Lubricating Oils from Anthracite Tar (Gewinnung viskoser Schmieröle aus Steinkohlenteer), F. Schreiber. Zeit. für angewandte Chemie, vol. 34, no. 65, Aug. 16, pp. 425–426, 3 figs. Describes process of recovery developed and perfected in Germany during recent years, and discusses properties and economic advantages of product known as "Ess" oil, to distinguish it from other tar oils.

Removal from Condensation Water. The Removal of Oil from Water of Condensation Through Electrolysis (Die Entölung von Kondenswässern durch Elektrolyse), Fritz Hoyer. Feuerungstechnik, vol. 10, no. 4, Nov. 15, 1921, pp. 33–34. Describes process and apparatus.

LUBRICATION

Automobile Chassis. Various Methods of Chassis Lubrication, Cornelius T. Myers. Automotive Industries, vol. 45, no. 22, Dec. 1, 1921, pp. 1067–1069. Compares lubricating materials and discusses various methods and devices. Condensed from paper read before Soc. Automotive Engrs.

Prime Movers. The Lubrication of Prime Movers, C. H. Bromley. Mech. World, vol. 70, no. 1821, Nov. 25, 1921, pp. 428–429. Discusses oils for steam turbines, emulsion and sludge, Diesel-engine lubri-

cation, etc. (Abstract). Paper read before System Operators' Assn.

LUMBER

Care in Storage. The Care and Protection of Lumber in Storage, H. A. Sackett. Ry. Age, vol. 71, no. 24, Dec. 10, 1921, pp. 1133–1136, 9 figs. Sanitary precautions to prevent decay; building of piles; and protection against fire.

M

MAGNESIUM ALLOYS

Electron Metal. The Magnesium Alloy "Electron," S. Beckinsale. Metal Industry (N. Y.), vol. 19, no. 11, Nov. 1921, p. 433. Gives chemical analysis of three specimens; hardness and compression tests; microscopic examination; machining properties.

MACHINE SHOPS

British. Famous British Works. Eng. Production, vol. 3, no. 59, Nov. 17, 1921, pp. 458–460, 7 figs. Works of Ruston & Hornsby, Ltd., Lincoln, known as Sheaf Iron Works, Wood Works, Motor Works, Boiler Works, and Steam Navy Works.

Design. The Design and Construction of Engineering Workshops—XXIV, Ernest G. Beck. Mech. World, vol. 70, no. 1817, Oct. 28, 1921, pp. 342–343, 6 figs. Discusses orientation of roofs; glare, glazing, screening, ventilation, etc. (To be continued).

MACHINE TOOLS

Automatic. Automatic Machine Tools in Relation to Production Problems, Henry Baker. Machinery (Lond.), vol. 19, no. 477, Nov. 17, 1921, pp. 181–185. Application of mathematical methods to tool setting; idle time; stoppages; economy of extra tools or extra machines.

Cooling-Water Pumps for. Cooling-Water Pumps for Machine Tools (Kühlwasserpumpen für Werkzeugmaschinen), Alfred Schacht. Fördertechnik u. Frachtverkehr, vol. 14, no. 21, Oct. 14, 1921, pp. 258–259, 2 figs. Describes motor-driven Elmo machine-tool cooling pumps patented by the Siemens-Schuckert Works, for which both direct and alternating current can be used.

Improving Details. Tool Details that Improve the Finish of Work in a Machine Shop. Eng. & Indus. Management, vol. 6, no. 21, Nov. 24, 1921, pp. 586–589, 12 figs. Gives practical advice on raising standard of quality of work, and details for improving machine tools, together with explanatory diagrams.

Operation Control. Some Notes on the Operating Control of Machine Tools, N. F. Stockbridge. British Machine Tool Eng., vol. 1, no. 12, Nov.-Dec. 1921, pp. 406–412, 11 figs. Discusses the various adjustments of the radial drilling machine up to 4 ft. 6 in. radius.

MALLEABLE CASTINGS

Annealing. Annealing Malleable Cast Iron (Le recuit de la fonte malléable), Christian Kluytmans. La Fonderie Moderne, no. 8, August 1921, pp. 209–218, 2 figs. Shows that on annealing depends the success or failure of malleability, if composition is correct.

MARINE STEAM TURBINES

Drive. Stal's New Marine Turbine Drive (Stal:s nya turbomekaniska fartygsmaskineri), O. A. Wiberg. Teknisk Tidskrift, vol. 51, no. 9, Sept. 28, 1921, pp. 89–95, 10 figs. Describes turbine and propeller arrangements and gives tables showing saving effected.

METAL SPRAYING

Schoop Process. Metal Spraying by the Schoop Process, Sidney Mornington. Compressed Air Mag., vol. 26, no. 11, Nov. 1921, pp. 10293–10295, 5 figs. Promises to be of great industrial value for applying zinc or lead to bridges, pontoons, railway cars, and other equipment exposed to action of the elements or exhaust gases.

METALS

Elasticity. Testing Machine Indicating the Elastic limit and the Modulus of Elasticity of Metals (Machines d'essais, donnant la limite élastique et le module d'élasticité des métaux), R. Guillery. Comptes Rendu des Séances de l'Académie des Sciences, vol. 173, no. 20, Nov. 14, 1921, pp. 907–909, 1 fig. Describes new method and apparatus.

Fatigue. An Investigation of the Fatigue of Metals, H. F. Moore and J. B. Kommers. University of Illinois Bul., vol. 19, no. 8, Oct. 24, 1921, 185 pp., 46 figs. Report of investigation conducted by Engineering Experiment Station in coöperation with Nat. Research Council, Engineering Foundation, and Gen. Elec. Co. Concludes that phenomenon known as fatigue under repeated stress might better be called progressive failure of metals. Most probable explanation seems to be that such failure is progressive spread of microscopic fractures. Bibliography. See also Eng. & Contracting, vol. 56, no. 26, Dec. 28, 1921, pp. 593–596, 5 figs.

Hardening. On the Theory of the Hardening of Metals, Kotaro Honda. Chem. & Met. Eng., vol. 25, no. 22, Nov. 30, 1921, pp. 1001–1003. Thinks that hardness in metals is due in part to forces between atoms and in part to an interlocked, strained crystalline structure.

Light and Extra Light. Light and Extra Light Metals (Les Métaux blancs légers et ultra-légers), R. de Fleury. La Fonderie Moderne, no. 10, Oct. 1921, pp. 294–298. Discusses alloys with aluminum or magnesium base; compares light and heavy metals casting of aluminum; treatment of light metals; alloys of aluminum.

MILLING

Problems. Some Miller Problems—How They Were Solved, H. A. Wilson. Can. Machy., vol. 26, no. 20, Nov. 17, 1921, pp. 33–34, 4 figs. Milling steel parts to within limits of .002 in. at the rate of 600 per hour; milling four tables at one time; value of gang milling.

MILLING CUTTERS

Action of. On the Art of Milling, John Airey. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 783–789 and 798, 17 figs. Account of investigation undertaken at University of Michigan for purpose of finding rational basis for action of milling cutter. It is shown that metal is removed more efficiently with thick than with thin chips; thus, under usual conditions, cutter with fewest teeth gives greatest efficiency. Formulas for determining number of teeth for known diameter of cutter and for determining depth are included.

MOLDING METHODS

Jarring Machines. Germans Jar Molds Mechanically, U. Lohse. Foundry, vol. 49, no. 23, Dec. 1, 1921, pp. 934–938, 8 figs. Compares different methods of packing sand in molds; mechanical jarring machines, both with and without shock absorbers are described in detail. (Abstract). Stahl und Eisen, Sept. 1, 1921.

MOTOR-TRUCK TRANSPORTATION

Costs. A Formula Covering Costs of Heavy Motor Trucking, Charles Hine. Ry. Age, vol. 71, no. 22, Nov. 26, 1921, pp. 1045–1046, 1 fig. Shows superiority of time basis over ton-miles or truck-miles for computing expenses.

MOTOR TRUCKS

British Types. Engineering Features of British Truck Models, M. W. Bourdon. Automotive Industries, vol. 45, no. 20, Nov. 17, 1921, pp. 958–963, 14 figs. Describes new design features in the 6-ton Maudslay, 4-ton Dennis, and other trucks.

Electric vs. Gasoline. Electric Vehicle Operation Cheaper than Gasoline Truck, Walter R. Metz. Elec. World, vol. 78, no. 24, Dec. 10, 1921, pp. 1173–1174, 2 figs. Operating costs of electric trucks in government service in Washington, D. C., compared with cost of gasoline trucks under similar conditions; electric trucks superior for city requirements.

Vibration, Reduction of. Reducing Destructive Vibration in Equipment. Elec. Traction, vol. 17, no. 11, Nov. 1921, pp. 805–809, 9 figs. Discusses crystallization and fatigue, experience in motor-truck field, use of ball and roller bearings, cushioning shocks, types of cushion wheels, etc.

N

NICKEL STEEL

Invar. Properties and Uses of Invar Metal (Les propriétes et les applications de l'invar et de l'invar), Ch.-Ed. Guillaume. Bulletin de la Société Industrielle de Mulhouse, vol. 87, no. 6, June-July-August 1921, pp. 291–318, 13 figs. Discusses nickel-steel alloys and their magnetic properties; expansion of invar, which name is derived from "invariable;" also "elinvar" metal, having an invariable modulus of elasticity. Used for watch compensation, etc.

NOZZLES

Measurement of Flow. Use of Nozzles for Measuring Flow, W. Trinks. Power Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1044–1045, 4 figs. Methods of reducing fluctuations in flow to and from air compressors and steam engines.

O

OIL ENGINES

Function of. Function of the Heavy Oil Engine in Connection with the General Supply of Electricity, Geoffrey Porter. Petroleum World, vol. 13, no. 254, Nov. 1921, pp. 466–470. Discusses fuels available, compares steam and oil engine stations; local versus bulk electricity supply; etc. (Abstract). Paper read before Diesel Engine Users Assn.

Marine. Worthington Airless-Injection Oil-Engine. Motorship, vol. 6, no. 11, Nov. 1921, pp. 872–875, 12 figs. Details of a new marine motor for small commercial vessels developed at Blake Works, East Cambridge; successful tests run on regular steam-boiler fuel oil with low-consumption results.

Two-Cycle. A Two-Cycle Oil Engine. Engineer, vol. 132, no. 3438, Nov. 18, 1921, p. 544, 3 figs. Describes two-stroke hot-bulb type constructed by Marshall, Sons & Co., Ltd., Gainsborough.

OIL FUEL.

Textile Mills. Oil Fuel for Textile Works, J. Veen Stevens. Eng. & Indus. Management, vol. 6, no. 21, Nov. 24, 1921, pp. 597–598. Tests for standardizing quality. Paper read before British Assn. of Mgrs. of Textile Works.

OPEN-HEARTH FURNACES

Coke-Oven Gas in. Using Coke Oven Gas in Martin Furnaces (Utilisation du gaz de fours a coke pour le chauffage des fours Martin), Jean Dupuis. Révue de L'Industrie Minérale, no. 20, Oct. 15, 1921, pp. 627–633. Discusses combustion using rich gas, rich and poor gas without mixing, and rich and poor mixed, and experiments carried out.

Ports, Improving. Improving Ports of Open Hearths, John W. Kagarise. Iron Trade Rev., vol. 69, no. 22, Dec. 1, 1921, pp. 1417–1421 and 1426, 6 figs. Various types of water-cooled ports are described. Using by-product coke-oven gas introduces difficulty. Paper read before Am. Iron & Steel Inst.

Improvements in Open-Hearth Port Construction, John W. Kagarise. Iron Age, vol. 108, no. 21, Nov. 24, 1921, pp. 1324 and 1326–1329. Early types; water-cooled ports; the McKune system and the Venturi and Egler furnaces with some results. Paper read before Am. Iron & Steel Inst.

OXY-ACETYLENE WELDING

Mild Steel. A Survey of Oxyacetylene Welding, Lorn Campbell, Jr. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 320–321 and (discussion) 321–322. Discusses the subject as a factor of efficiency in manufacturing; gives reasons why rivets should be replaced by welds; outlines mild steel welding and describes apparatus.

P

PAINTS

Drying. Artificial versus Natural Means of Drying Paint and Varnish, R. E. Lippert. Jl. Soc. Automotive Engrs., vol. 9, no. 5, Nov. 1921, pp. 335–340 and (discussion) 340–343, 13 figs. Describes process for drying coats of paint and varnish by adding heat and moisture simultaneously to air surrounding siccative coatings through employment of mechanical devices; also describes several humidifying devices.

PATTERNMAKING

Layout and Equipment. Pattern-making Lay-out and Equipment, James Edgar. Eng. & Indus. Management, vol. 6, no. 22, Dec. 1, 1921, pp. 624–625. Practical advice covering essential features of organization. Notes on type of vice, position of machines, and sawing machine.

PATTERNS

Storage. The Organization of a Pattern Stores, H. Varley. Eng. & Indus. Management, vol. 6, no. 19, Nov. 1921, pp. 522–525, 10 figs. Describes storage method and manner of running stores which is claimed to be common-sense application of systematic routine reduced to its simplest terms.

PETROLEUM

Refining. Modern Oil Refineries (Moderne oliefabrieksinstallatie), F. C. Huygen. Ingenieur, vol. 36, no. 43, Oct. 22, 1921, pp. 842–847, 12 figs. Describes equipment and operations of plant of Atrecht Machine Works, including hydraulic, chemical and electrolytic methods; hydrogenations; etc.

PIGMENTS

Paint and Rubber. A Photomicrographic Method for the Determination of Particle Size of Paint and Rubber Pigments, Henry Green. Jl. Franklin Inst., vol. 192, no. 5, Nov. 1921, pp. 637–666, 13 figs. Describes method of determining "diameter" of paint and rubber pigments, by first taking a photomicrograph of sample, at carefully ascertained magnification, and again enlarging by means of a stereopticon and then measuring particles on projecting screen.

PIPE, CAST-IRON

Centrifugal Casting. Manufacture of Cast Iron Pipe by Centrifugal Methods, F. W. Hudson. Contract Rec., vol. 35, no. 48, Nov. 30, 1921, pp. 1038–1039, 2 figs. Describes the DeLavaud process and machinery. Comparison of centrifugal product with sand-cast pipe.

PIPE, STEEL

Protective Covering. Protective Covering for Steel Pipe, L. M. Klauber. Gas Age-Rec., vol. 48, nos 14 and 15, Oct. 22 and 29, 1921, pp. 478–484 and 514–516, 21 figs. Oct. 22: Describes method of covering pipe for protection in corrosive soils used by San Diego Consolidated Gas & Elec. Co. The clean pipe is dipped into hot asphalt, wrapped with chemically and electrically resistant asbestos felt redipped in asphalt and wrapped spirally with burlap. Oct. 29: Tests with some coverings, materials for wrapping, life of pipe, etc.

PISTONS

Machining Bosses. Machining Piston Bosses. Eng. Production, vol. 3, no. 58, Nov. 10, 1921, p. 450, 3 figs. Describes method for intensive production.

PLANERS

Helical-Geared Drive. The New Gray Planer. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 285–289, 6 figs. Machine with helical-geared tabl drive, designed to render maximum service under modern requirements.

POWER

Costs. How to Follow Up Power Costs—II, N. A. Craigue. Indus. Management, vol. 62, no 6, Dec. 1921, pp. 354–356, 1 fig. Discusses various methods of distribution, such as by estimated percentages, by metered amounts, and unit cost or cost constant method.

Hydraulic, Storage of. Mechanical Storage of Power in Italy, G. Müller. Power, vol. 54, no. 21, Nov. 22, 1921, pp. 804–805, 2 figs. Discusses storage of hydraulic energy by using surplus power during periods of high water or low demand, to pump water from tailrace back to higher level for use during peaks or periods of drought. Notes on the Viverone plant,

Funghera mechanical storage plant, and a large one under construction.

POWER GENERATION

By-Product Recovery. The Generation of Power with Recovery of By-Products (Kratterzeugung mit Gewinnung von Wertstoffen), H. Kreyssig. Gas- u. Wasserfach, vol. 64, no. 35, Sept. 3, 1921, pp. 587–590. Study of methods for the complete utilization of coal in connection with generation of electrical energy. Merits of gas and oil turbines.

Fuel Economy. Fuel Economy by the Adoption of Scientific Management in Steam (Power) Generation and Utilisation, David Brawnlie. Eng. & Indus. Management, vol. 6, nos. 17, 18, 19, 20, 21 and 22, Oct. 27, Nov. 3, 10, 17, 24 and Dec. 1, 1921, pp. 475–478, 516–520, 549–552, 559–562, 593–594 and 626–630 and 637, 31 figs. Oct. 27: Boiler feedwater meters. Nov. 3: Steam meters. Nov. 10: Steam meters and feedwater regulators. Nov. 17: Feedwater regulators and coal weighing. Nov. 24: Coal weighing. Dec. 1: Economizers.

POWER PLANTS

Code on Definitions and Values. Code on Definitions and Values. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 805–810 and 821. Preliminary draft of fourth in series of 19 codes in preparation by A.S.M.E. committee on power tests codes.

Design. Developments in Power Station Design. Engineer, vol. 132, nos. 3447, 3438, 3439 and 3440, Nov. 11, 18, 25 and Dec. 2, 1921, pp. 502–504, 5 figs; 530–532, 8 figs.; 558–559, 4 figs.; and 600–601, 7 figs. Nov. 11: Lopulco pulverized-coal feeders and equipment. Nov. 18: Self-cleaning multiple-retort stokers; ash-removal equipments. Nov. 25: Coal-storage system of Ed. Bennis & Co., Ltd., and ash removal from boiler houses. Dec. 2: Pneumatic coal-handling plant at Bankside electric generating station, London.

Oiling Systems. Central Oiling Systems for Power Plants. Power House, vol. 14, no. 21, Nov. 5, 1921, pp. 32–33. The treatment of oil for continuous use; correct lubrication; impurities; precipitation; filtration; entrained water; action of heat; filtering materials; separation of water.

Operation. Refinements of Practice in Modern Power Plants, I. L. Kentish-Rankin. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1190–1192. Turning steam into cold pipe lines; handling hot water; precautions for instrument piping; flue dusts and their chemical actions; moisture in superheated steam lines.

Records and Accounting. Power Plant Records and Accounting, Einar Winholt. Power Plant Eng., vol. 25, no. 24, Dec. 15, 1921, pp. 1193–1196, 6 figs. Discusses total cost of operating power plant, distribution of cost, and gives forms.

Waste in. Waste in Industrial Power Plants, David Moffat Myers. Management Eng., vol. 1, no. 6, Dec. 1921, pp. 370–371. Notes on how to determine efficiency of operation.

POWER TRANSMISSION

Waves. Wave Transmission of Power. Steamship, vol. 33, no. 389, Nov. 1921, pp. 142–154, 13 figs. Theoretical discussion by G. Constantinesco. Discusses power transmission by waves through liquids and its application to rock drills, riveters, etc. made by W. H. Dorman & Co., Shafford, Eng.

PRODUCER GAS

Coke-Oven Heating. Producer Gas for Coke Oven Heating. Colliery Guardian, vol. 122, no. 3177, Nov. 18, 1921, pp. 1403–1404, 5 figs. Discusses trend of progress in coke industry. Notes on Koppers regenerative coke oven and regenerative gas oven.

PULVERIZED COAL

Assay Muffles. Firing Assay Muffles with Pulverized Coal, E. H. Hamilton. Min. & Metallurgy, no. 180, Dec. 1921, p. 24, 2 figs. Describes satisfactory burning of pulverized coal in assay furnaces of U. S. Smelting Refining & Mining Co., Midvale, Utah.

Boiler Equipment. Burning Anthracite Mine Waste Efficiently, O. M. Rau. Power, vol. 54, no. 22, Nov. 29, 1921, pp. 828–832, 8 figs. Results of tests obtained by burning pulverized anthracite coal in Philadelphia Rapid Transit Co.'s power plant. Pulverizing equipment installed for ten boilers.

Costs, Arizona. Experience with Powdered Coal in Arizona, J. B. Johnson. Elec. World, vol. 78, no. 23, Dec. 3, 1921, pp. 1121–1123, 1 fig. Costs less than fuel oil per B.t.u. in this case; detailed costs of pulverizing given.

Firing with. Firing With Powdered Coal (Het stoken met kolenpoeder), I. Franco. Ingenieur, vol. 36, no. 45, Nov. 5, 1921, pp. 875–892 and (discussion) 892–894, 50 figs. Notes on consumption of anthracite and other fuels, pulverized-coal installations, pulverizers, etc. Discusses advantages, application in locomotives, etc.

Power-Plant Equipment. Burning Pulverized Anthracite Mine Waste, O. M. Rau. Elec. Ry. Jl., vol. 58, no. 22, Nov. 26, 1921, pp. 945–949, 8 figs. Results of tests obtained by burning pulverized anthracite coal in Philadelphia Rapid Transit Company's power plant; pulverizing equipment installed for ten boilers.

PUMPS

Air-Lift. Air-Lift in Theory and Practice, A. W. Allen. Min. & Sci. Press, vol. 123, no. 21, Nov. 19, 1921, pp. 711–712. Discusses essentials for air lifting, design of rising main, elevating solids by air lift, elasticity, and advantages and disadvantages of air lift.

Rotary. Imbye Pumping, with Special Reference to the Feuerheerd Pump, S. H. Cashmore. Colliery Guardian, vol. 122, no. 3172, Oct. 14, 1921, pp. 1073–1074, 5 figs. Comparison of various types of pumps; describes the Feuerheerd pump which is claimed to have a great future. Read before South Staffordshire and Warwickshire Inst. Min. Engrs.

PUMPS, CENTRIFUGAL

Impellers. Open vs. Closed Impellers in the Brockton Sewage Pumping Plant, H. S. Crocker. Eng. News-Rec., vol. 87, no. 21, Nov. 24, 1921, pp. 854–856. Experience at Brockton, Mass., shows that open-type impeller properly designed will give greater output and higher efficiency than enclosed one for small high-speed pumps.

PYROMETERS

Féry. The Measurement of Temperature—XV, P. Field Foster. Mech. World, vol. 70, no. 1819, Nov. 11, 1921, pp. 382–383, 8 figs. Describes the Féry radiation pyrometer.

High-Temperature Measurement. The Measurement of High Temperatures with the "Ardometer" and the Holborn-Kurlbaum Pyrometer (Die Messung hoher Temperaturen mit Ardometer und Holborn-Kurlbaum-Pyrometer), Georg Keinath. Siemens-Zeit., vol. 1, nos. 9 and 10, Sept. and Oct. 1921, pp. 331–340, and 358–364, 20 figs. Describes two instruments, one measuring by contrast between a hot lamp filament and the hot body; and other concentrating heat from hot body upon a small thermocouple the e.m.f. of which is measured on millivoltmeter calibrated in degrees. They give desired reading within a few seconds with accuracy of ±10 deg. cent.

Recording and Non-Recording. Pyrometer Solves Temperature Problems, John P. Goheen. Foundry, vol. 49, no. 23, Dec. 1, 1921, pp. 938–939. Discusses non-recording and recording pyrometers and their application, temperature control of furnaces, etc. Paper to be read before Am. Inst. Min. & Met. Engrs.

R

RADIOMETALLOGRAPHY

Industrial Applications. Industrial Applications of Radiometallography (La Radiometallographie, sa pratique et ses applications industrielles). Le Génie Civil, vol. 79, no. 16, Oct. 15, 1921, pp. 321–323, 6 figs. Describes equipment of X-ray testing laboratory.

RAILWAY ELECTRIFICATION

Boston-Washington. Plan for Electrifying Sections of Eleven Railroads. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 739–743, 9 figs. Superpower report provides for consolidation of power supply in region between Boston and Washington.

Brazil. The Paulista Railway Electrification, S. B. Cooper. Ry. & Locomotive Eng., vol. 34, no. 11, Nov. 1921, pp. 304–306, 3 figs. Discusses new line of Companhia Paulista de Estradas de Ferro, between Jundiahy and Campinas, Brazil. Baldwin-Westinghouse electric locomotives, type 2-4-0+0-4-2 for passenger service, and 0-6-0+0-6-0 for freight.

Chile. Chile Starts on Extensive Electrification Program. Elec. Ry. Jl., vol. 58, no. 23, Dec. 3, 1921, pp. 991–993, 5 figs. First zone of State Railways, comprising 144 miles, which includes Valparaiso-Santiago line, to be completely electrified at 3,000 volts d.c.

France. Electrification of French Railways and American Experience (L'Electrification des chemins de fer Français et l'experience Americaine), A.-R. Garnier. La Technique Moderne, vol. 13, nos. 4, 5, 7 and 8, Apr., May, July and Aug. 1921, pp. 167–173, 209–217, 305–315 and 346–356, 19 figs. Apr.: Gives tabulation of efficiency of single- and three-phase systems; cost of installation; American and Canadian lines; etc. May: Reviews French, Swiss, Italian, German and American electrification; power, substations and their equipment, motor generators, locomotives, etc. July: High- and low-tension apparatus, direct control for fast trains, auxiliaries, transmission systems, etc. Aug.: Practical results obtained in Europe and America; tables of power consumption etc. of various lines; further electrification projects by French roads. (Concluded.)

RAILWAY OPERATION

Automatic Train Control. An Automatic Mechanical Train Controller. Engineer, vol. 132, no. 3437, Nov. 11, 1921, pp. 520–521, 4 figs. Details of device for automatically giving warning in cab of locomotive of position of signals on line, and for simultaneously applying brakes.

Automatic Train Control, North Eastern Railway. Ry. Gaz., vol. 35, no. 21, Nov. 18, 1921, pp. 765–767, 5 figs. Describes system which has been in use for many years, and is applicable to engines and stock fitted with Westinghouse, Westinghouse and vacuum combined, or vacuum brakes alone.

The "Daniels" Automatic Train-Stop. Ry. Gaz., vol. 35, no. 19, Nov. 4, 1921, pp. 683–685, 5 figs. New, exclusively mechanical, train stop, designed to give warning at distant signal and to cause a partial application of brakes, and at stop signals, should they be passed at "danger," to cause a further positive brake application, and to shut off steam. Apparatus provides for a distinct audible indication as a "clear" signal of either type is passed.

Lackawanna. Lackawanna Success the Result of Supervision, Charles W. Foss and James G. Lyne. Ry. Age, vol. 71, nos. 22 and 23, Nov. 26 and Dec. 3, 1921, pp. 1027–1032 and 1097–1102, 24 figs. Nov. 26: Notes on service, elimination of grades and curvature, locomotives, freight and passenger cars, and handling of coal. Dec. 3: Details of handling of coal and manifest freight.

Light Railways. On the Question of Operation of Light Railways, Working Rules and Regulations, F. Level. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1471–1482. Summary of replies from 106 administrations to questions regarding classes of tickets, issuing, collecting, checking, etc.

Safety Appliances. On the Question of Safety Appliances on Light Railways, A. Bonnevie. Bul. Int. Ry. Assn., vol. 3, no. 10, Oct. 1921, pp. 1539–1588. Gives tabulation of lines in various countries and the length, gage, gradients, curve radii, maximum load, brakes, couplings, speeds, number of trains, track, signals, etc.

Standardization. Railway Standardization and Operation (Normung und Wartung), H. Mattersdorff. Verkehrstechnik, vol. 38, no. 24, Aug. 25, 1921, pp. 363–369, 8 figs. Notes on present status of standardization and its limitations; relations between standardization and operation; and advantages to be gained by a standardized operation.

RAILWAY REPAIR SHOPS

Modern. Modern Railway Shops and Repair Shops (Neuzeitliche Eisenbahn-Betriebs- und Ausbesserungswerke), M. Osthoff. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 44 and 45, Oct. 29 and Nov. 5, 1921, pp. 1131–1134 and 1187–1191, 13 figs. Describes following plans: (1) Railway shop for dismantling of locomotives, equipped with a traveling wide-gage grab slewing crane, and connected with which is an efficient repair shop and a cattle-car cleaning house; (2) railway repair shop without traveling platform, in which locomotives, tenders and boilers can be mounted in either vertical or horizontal position.

RAILWAY SHOPS

Operations and Apparatus. Railroad Shop Operations and Apparatus, Frank A. Stanley. Am. Mach., vol. 55, no. 23, Dec. 8, 1921, pp. 922–923, 9 figs. Describes "home-made" acetylene gas generator; cutting continuous threads on staybolts; systematic arrangement of tools.

RAILWAY SIGNALING

Liverpool Overhead Railway. The Re-Signalling at the Liverpool Overhead Railway. Engineer, vol. 132, no. 3436, Nov. 4, 1921, pp. 488–489, 3 figs. Signaling is arranged on a 2-min. service, but actually is based on interval between trains of 100 sec. Notes on overlaps; light signals; color-light signals; track transformers, relays, etc.; train stops; and emergency cross-over roads.

Track Circuits, A.C. Shunting Characteristics of the Relay in an A-C. Track Circuit Employed in Railroad Signaling, C. F. Estwick. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 12, Dec. 1921, pp. 919–925, 5 figs. Study of various characteristics of track circuit particularly in connection with shunting action of relay.

RAILWAY TIES

Wooden. Wooden Ties (Holzschwellenbeschaffung), E. Stephan. Verkehrstechnik, vol. 38, special no., Sept. 1921, pp. 408–410. Discusses relative economy of treated and untreated ties.

RAILWAY TRACK

Crossings. Railroad Crossings and Crossing Signs, R. S. Messenger. Elec. Ry. Jl., vol. 58, no. 17, Oct. 22, 1921, pp. 744–745. Suggests standardization to reduce accidents. (Abstract). Paper read before National Safety Council.

RAILWAY YARDS

Shunting Cars. Suggestions for the Most Economical Shunting of Railway Cars on Private Sidings (Welche Mittel gibt es, um das Rangieren der Eisenbahnwaggons auf den Privatanschulssgleisen auf möglichst billige Weise zu erledigen-), Ernst Varenkamp. Fördertechnik u. Frachtverkehr, vol. 14, no. 22, Oct. 28, 1921, pp. 274–277. Rope shunting installations and shunting winches.

REFRACTORIES

Research. Report of the Refractories Materials Committee. Gas World, vol. 75, no. 1943, Oct. 15, 1921, pp. 322–324 and (discussion) 324–325, 1 fig. Notes on jointing materials, including softening-point of mixtures of silica brick and clay firebrick, and mixtures of fireclay with fireclay grog; research.

REFRIGERATION

Total-Heat Diagram. Solving Refrigerating Problems by the Total Heat Diagram. Power, vol. 54, no. 22, Nov. 29, 1921, pp. 839–841, 3 figs. Describes use of Mollier diagram or total heat chart based on Goodenough's table of the properties of ammonia.

REFUSE DISPOSAL

Smelting. The Utilization of Refuse Through Smelting (Die Müllverwertung durch Schmelzung), Hermann Koschmieder. Gesundheits-Ingenieur, vol. 44, no. 35, Aug. 27, 1921, pp. 429–432. Refers to unsuccessful results of tests with smelting of refuse in Berlin according to Wegner system, and describes new process which, it is claimed, gives promise of better results.

ROLLING MILLS

Electrically Driven. Motor Equipment for Main Drive of Rolling Mills. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 647–653. List of particulars of electrically-driven rolling mills.

The Future of the Electrically Driven Rolling Mill, L. Rothera. Electrician, vol. 87, no. 2270, Nov. 18, 1921, pp. 632–633. Discusses cost of production and electric drive, influence of power

factor, and the chance for the gas engine with available gas supplied from blast furnaces and coke ovens.

Flywheel Engines. Flywheel Rolling-Mill Engines (Ueber Schwungrad-Walzenzugmaschinen), K. Möbus. Stahl u. Eisen, vol. 41, no. 46, Nov. 17, 1921, pp. 1649–1653, 7 figs. Discusses different types of single-cylinder steam engines in capacity of rolling-mill engines, particularly in connection with central condensation plants; and describes and recommends special type of machine, consisting of a combination of steam and gas engine.

Motors, Size of. Factors which Influence the Size of Rolling Mill Drives, L. Rothera. English Elec. Jl., vol. 1, no. 7, July-October 1921, pp. 291–297, 8 figs. Discusses power demand for rolling various sections, output required and methods of rolling, as factors in determining size of motor.

ROPE

Manila. Results of Some Tests of Manila Rope, Ambrose H. Stang and Lory R. Strickenberg. U. S. Bur. of Standards Technologic Papers, no. 198, Sept. 15, 1921, 11 pp. Summary of results of tensile tests of 368 specimens of rope, all of which were 3-strand, regular lay manila rope having diameters from 1/8 in. to 4 1/2 in. are given in tables and graphically. Gives formula for determining average breaking load as function of diameter of rope. Ropes showed continually varying modulus of elasticity and no well-defined proportional limit.

RUBBER

Aging. The Aging of Rubber, Andrew H. King. Chem. & Met. Eng., vol. 25, no. 23, Dec. 7, 1921, pp. 1039–1042. Aging tests and aging hypothesis; acceleration of oxidation; depolymerization; comparison between still and active aging.

Microsectioning. Recent Development in the Art of Rubber Microsectioning, Henry Green. Jl. Indus. & Eng. Chem., vol. 13, no. 12, Dec. 1921, pp. 1130–1132, 11 figs. Describes chemical method as an alternative to freezing method. Paper read before Am. Chem. Soc.

Vulcanization. The Relation between Coefficient of Vulcanization and Mechanical Properties of Vulcanized Rubber, O. de Vries. Jl. Indus. & Eng. Chem., vol. 13, no. 12, Dec. 1921, pp. 1133–1134. Results of investigations showing that the natural accelerator or accelerators in rubber cause an increase in coefficient of vulcanization for fixed mechanical properties which amounts to about 0.5 for all types of quick-curing rubber, independent of their composition.

S

SAFETY

Inspection. Safety Inspectors and Inspections, John A. Dickinson. Am. Mach., vol. 55, no. 22, Dec. 1, 1921, pp. 887–869. Different types of inspection. Importance of standardizing safeguards. Advantages of helping inspectors.

SCALES

Inspection and Maintenance. Inspection and Maintenance of Weighing Scales, Herbert T. Wade. Management Eng., vol. 1, no. 5, Nov. 1921, pp. 289–294, 10 figs. Describes scale-inspection department of the Scovill Mfg. Co., Waterbury, Conn. Scale service organizations.

Locomotive. Locomotive Weighing Plant of Large Capacity, Carl C. Bailey. Ry. Mech. Engr., vol. 95, no. 12, Dec. 1921, pp. 749–750, 3 figs. Heavy scale is housed in special building with equipment for determining all wheel loads at one time.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT; TAYLOR SYSTEM.

SEAPLANES

Deck-Landing Amphibian. The Supermarine "Seal," Mark II. Flight, vol. 13, no. 44, Nov. 3, 1921, pp. 713–715, 5 figs. Has cruising radius of five hours; total military load, including fuel is 1790 lb. Describes details of construction as far as public, of this deck-landing amphibian fleet-spotter.

German. Some New German Seaplanes, Erik Hildsheim. Aviation, vol. 11, no. 21, Nov. 21, 1921, pp. 594–596, 11 figs. Describes L.F.G. commercial seaplanes, new Dornier flying boats, and gives table of data.

Gliders. Hydroplanes (Gliders) With Multiple Redans and Air Screws (Sugli idroplani (glisseurs) a redans multipli ed elica aerea), Dino Giuliani. Revista Marittima, vol. 54, no. 10, Oct. 1921, pp. 169–183, 5 figs. Describes existing types of flying boats, hydroplanes, etc. and gives formulas for calculations.

SEMI-DIESEL ENGINES

Beardmore. Construction of Internal-Combustion Engines. Shipbldg. & Shipg. Rec., vol. 18, no. 22, Dec. 1, 1921, pp. 703–708, 9 figs. Describes the Beardmore semi-Diesel oil engines.

SHAPERS

Use in Production Work. Production Shaping. Machy. (N. Y.), vol. 28, no. 4, Dec. 1921, pp. 272–276, 9 figs. Use of shapers in production work in machine-tool building plants.

SILICA BRICK

Manufacture and Use. Manufacture and Use of Silica Brick, Jefferson Middleton. Cem., Mill & Quarry, vol. 19, no. 9, Nov. 5, 1921, pp. 25–27. How material is ground and washed. Burning brick in circular down-draft kilns. Used for purposes where temperatures are high. (Abstract). Mineral Resources of U. S.

STANDARDIZATION

Germany. Industrial Standardization in Germany. Automotive Industries, vol. 45, no. 23, Dec. 8, 1921, p. 1127. Discusses national standardization as developed in Germany under post-war conditions.

Industrial Standardization in Germany, P. G. Agnew. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 8, Nov. 1921, pp. 794–796. Describes advanced state of industrial standardization in Germany. 144 approved standards sheets have been issued and over 500 others have been developed Notes on organization and methods of work.

Industrial. Industrial Standardization, Jl. Soc. Automotive Engrs., vol. 9, no. 6, Dec. 1921, pp. 359–435, 66 figs. A number of articles on standardization, including standardization in Germany, S.A.E. standardization, automobile standardization in Great Britain, decreasing production costs through standardization, and reports of divisions to A.S.E. Standards Committee.

Inter-works. Standardisation and Assimilation, H. Varley. Eng. & Indus. Management, vol. 6, no. 20, Nov. 17, 1921, pp. 554–556. Writer advances plea for wider adoption of inter-works standardization and explains where and how it can be performed and applied.

STANDARDS

German N.D.I. Report. German Industry Committee on Standards (Normenausschuss der Deutschen Industrie). Betrieb; vol. 4, no. 1, Oct. 8, 1921, pp. 1–9, 8 figs. Proposals of the Board of Directors for blank hexagonal nuts, blank washers, low dimensions for drills and countersinks, diameters of core drills; sink-water traps with openings and with covers. Proposed standards for copper and brass.

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Importance of. Executives Should Foster Use of Standards, Herbert Chase. Automotive Industries, vol. 45, no. 23, Dec. 8, 1921, pp. 1101–1107, 2 figs. Proper use of standard specifications, fittings and dimensions tends to eliminate waste, save time and cut expenses. Engineers know value of standards, but executives have, in general, failed to realize their importance and encourage their use.

STEAM-ELECTRIC PLANTS

Superpower System. Steam-Electric Central Stations Retained for the Superpower System, Arthur R. Wellwood. Power, vol. 54, no. 25, Dec. 20, 1921, pp. 969–972, 5 figs. Existing steam-electric stations retained represent 80 per cent of all such stations in Superpower Zone, and were chosen as result of detailed analysis and study based upon their 1919 performance. Operation of retained plants.

STEAM ENGINES

Exhaust. Simplification and Reduction of Operating Costs of Exhaust-Steam Engines by Simultaneous Utilization of Furnace Waste Heat (Vereinfachung und Betriebsverbilligung von Abdampfkraftanlagen durch gleichzeitige Ausnutzung von Ofenabwärme), Ernst Blau. Fördertechnik u. Frachtverkehr, vol. 14, no. 8, Apr. 15, 1921, pp. 88–90, 4 figs. Describes "Gefa" patented process for operation of exhaust-steam storage plants.

Heat Utilization. The Utilization of Heat in Steam Engines (Wärmeausnutzung bei Kraftmaschinen), K. Heilmann. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 40, Oct. 7, 1921, pp. 315–319, 6 figs. Discusses relations between exhaust-steam utilization and power generation.

STEAM PIPES

Flow in. Machinery and Pipe Arrangement Calculations—XIII, C. C. Pounder. Mech. World, vol. 70, no. 1819, Nov. 11, 1921, pp. 386–388, 1 fig. Continues discussion of safety-valve springs and gives examples and calculations; also discusses weight flow of steam through pipes.

Steam Flow in Pipes, F. M. Van Deventer. Power Plant Eng., vol. 25, no. 22, Nov. 15, 1921, pp. 1096–1098, 1 fig. Steam flow chart for superheated steam and table of pipe sizes.

STEAM POWER PLANTS

Heat-Balance Systems. Heat Balance in Steam Power Plants. Mech. Eng., vol. 43, no. 12, Dec. 1921, pp. 790–796 and 825, 8 figs. Particulars of systems employed in three large modern stations, namely, Delaware Station of Philadelphia Elec. Co., by E. L. Hopping; Hell Gate Station, by J. H. Lawrence and W. M. Keenan; and Colfax Station, by C. W. E. Clarke.

Sanitarium. Steam for Battle Creek Sanitarium. Power Plant Eng., vol. 25, no. 23, Dec. 1, 1921, pp. 1131–1138, 14 figs. Mechanical coal and ash handling, automatically controlled underfeed stokers, special water treatment and graphic record system.

STEAM TURBINES

Critical Speeds. Simplified Appromixations of Critical Speeds, G. Arrowsmith. Engineering, vol. 112, no. 2917, Nov. 25, 1921, pp. 717–720, 8 figs. Points out that critical speeds can in very many cases be obtained without resource to tedious graphical constructions of bending moment and deflection diagrams.

Efficiency Calculations. Turbine Efficiency Calculations, Paul F. Christopher. Power Plant Eng., vol. 25, no. 21, Nov. 1, 1921, pp. 1039–1042, 3 figs. Use of heat-enthropy diagram in calculation of efficiency; estimating power load to meet demands for exhaust steam.

Steam Consumption. A Simple Method of Finding Steam Consumption of Small Turbines. Power, vol. 54, no. 23, Dec. 6, 1921, pp. 895–896, 3 figs. Presents curves for determining water-rate factor for any turbine at any load.

STEEL

Alloy. See ALLOY STEELS.

Carburizing. Present Theories of Carburizing Steel H. B. Knowlton. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 543–548, 14 figs. Application of theories to commercial problems; effect of different temperatures on per cent and distribution of carbon in the case.

Chrome. See CHROME STEEL.

Composition and Properties. Principal Steels and Their Characteristics and Uses (Les principaux aciers de construction, leurs caracteristiques et leurs emplois), P. Dejean. La Houille Blanche, vol. 20, no. 55–56, July-August 1921, pp. 149–154, 3 figs. Gives tables of composition and properties. Discusses carbon steels, mild steels, cementation steels, corrosion resistant steels, etc., and their uses.

Ingots, Defects in. Defects in Ingots and Methods for Remedying Them (Les défauts des lingots et les methodes pour y remedier), Sigma. La Metallurgie, vol. 53, no. 47, Nov. 24, 1921, pp. 2185–2186. Summarizes results of investigations by L. Guillet, including piping, cracks, segregation, etc.

Low-Carbon, Strain Lines in. Strain Lines in Low Carbon Steel, A. Fry. Iron Age, vol. 108, no. 22, Dec. 1, 1921, pp. 1401–1402, 10 figs. New German etching method revealing effects on metal which has been stressed. Origin and character of lines. Translated from Stahl u. Eisen, Aug. 11, 1921.

Magnetic Analysis. Magnetic Analysis of Steel, R. L. Sanford. Am. Mach., vol. 55, no. 21, Nov. 24, 1921, pp. 836–839, 7 figs. Uses of electric current for inspection. Apparatus and method of operation; relation of magnetic to mechanical properties of steel. Advantages and difficulties.

Stainless. Stainless Steel and Its Engineering Applications. Mech. World, vol. 70, no. 1817, Oct. 28, 1921, pp. 346–348, 3 figs. Describes tests made with stainless-steel turbine blades at works of Th. Firth & Sons, Sheffield, showing that the blades remained absolutely unaffected. Also discusses manufacture of stainless steel and its properties.

STEEL CASTINGS

Welding. The Welding of Steel Castings (Das Schweissen von Stahlguss), L. Treuheit. Giesserei-Zeitung, vol. 18, nos. 29–30 and 31, Nov. 1 and 8, 1921, pp. 389–392 and 404–408, 19 figs. Discusses application of the different processes, with special consideration of electric arc and autogeneous welding.

STEEL, HIGH-SPEED

Heat Treatment. Proper Heat Treatment for High Speed Steel, J. L. Thorne. Can. Machy., vol. 26, no. 19, Nov. 10, 1921, pp. 36–37 and 53. Gives instances of improper heat treatment, object of high temperature furnace; quenching the tool; heating cutting edges.

Tool Steel. Action of Internal Stress on Tool Steel, C. Neil Greenwood. Forging & Heat Treating, vol. 7, no. 11, Nov. 1921, pp. 560–563. Discusses origins of internal stresses in pure metals and alloys, due to cold working and to suppression of phase changes by rapid cooling; volume changes taking place during heating and cooling. (Abstract). Paper read at joint meeting of Faraday Soc. with other institutions.

Tungsten Content. Measures Tungsten in Tool Steel, Arthur S. Townsend. Iron Trade Rev., vol. 69, no. 24, Dec. 15, 1921, pp. 1551–1553. New method determines content of this element in high-speed steel by specific gravity. Results show that accurate data can be obtained without chemical analysis. Tests are made in few minutes.

STEEL INDUSTRY

Research in. Research in the Steel Industry, John A. Mathews. Min. & Metallurgy, no. 180, Dec. 1921, pp. 11–13. Discusses ways in which research department of steel company may function in order to contribute to success.

STEEL WORKS

Brazil. Electric Iron and Steel Plant for Brazil, N. A. V. Paulson. Chem. & Met. Eng., vol. 25, no. 23, Dec. 7, 1921, pp. 1057–1061, 8 figs. This installation, first of its kind, includes two Swedish-type pig-iron furnaces, two bessemer converters, a Ludlum steel furnace and two merchant mills, all driven by electric power and heated by electric energy.

English. Methods in a Modern Steel Works. Eng. Production, vol. 3, no. 62, Dec. 8, 1921, pp. 545–548, 9 figs. Describes plant and equipment of Thos. Firth & Sons, Ltd., Sheffield.

Heat Economy in. Improving the Economy of Heat in Metallurgical Works (Zur Verbesserung der Wärmewirtschaft der Hüttenwerke), Gustav Neumann. Stahl u. Eisen, vol. 41, no. 44, Nov. 3, 1921, pp. 1561–1569, 3 figs. Deals with storage of excess blast-furnace gas in air heaters and its useful possibilities; utilization of waste heat from furnaces; preheating of combustion air and gas; utilization of producer steam for generation of mechanical energy; improvement in design of air heaters from thermo-technical standpoint.

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